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DEPARTMENT
OF AGRICULTURE

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# CORRIGENDUM.

**Studies of the Typhus-Rocky Mountain Spotted Fever group in South Africa I to IV.** *Onderstepoort Journal of Veterinary Science and Animal Industry*, 1939. 13, 1, 19-76.

**We take this early opportunity of correcting an unfortunate error occurring in the text. At the bottom of page 20 it is stated " nymphae identified as** ***Hyalomma aegyptium var. impressum*****, were placed " . . . In page 23 in the summary 2 the species is again cited as** ***Hyalomma aegyptium*****. These statements are correct. On page 70 at the bottom of paragraph 4 it is stated " We isolated a rickettsia . . . by feeding on a guinea-pig** ***Amblyomma hebraeum*** **nymphae." This is incorrect and should read** ***Hyalomma aegyptium*****.**

# CONTENTS.

## Vol. 14, Nos. 1 and 2.

SECTION I.

### Protozoology.

PAGE
Neitz, W. O. ...... Eperythrozoonosis in cattle.......... 9

SECTION II.

### Virus Diseases.

De Kock, G., Robinson, E. M. and Keppel, J. J. G. Swine fever in South Africa.......... 31

SECTION III.

### Parasitology.

Ortlepp, R. J.. ... South African helminths VII. Miscellaneous helminths, chiefly cestodes.......... 97
Monnig, H. O.. Treatment against lungworms (*Dictyocaulus filaria*) in sheep.......... 111
Monnig, H. O. ... *Marshallagia marshalli* (Ransom, 1907) Orloff, 1933, and a new species of this genus from sheep in South Africa 115

SECTION IV.

### Mineral Metabolism and Deficiency.

Du Toit, P. J., Louw, J. G. and Malan, A. I. A study of the mineral content and feeding value of natural pastures in the Union of South Africa...... 123
Malan, A. I., Du Toit, P. J. and Groenewald, J. W. Iodine in the nutrition of sheep. (Final report)...... 329
Van der Merwe, P. K.. The significance of fluorine traces in natural waters and a proposed method to effect their removal.......... 335
Van der Merwe, P. K.. A procedure for the micro determination of fluorine.... 359

SECTION V.

### Nutrition.

Marais, J. S. C. and Smuts, D. B. Further studies on the amino acid deficiencies of plant proteins.......... 387
Smuts, D. B. and Marais, J. S. C. The dry matter consumption of sheep on natural grazing in the Transvaal.......... 403
Smuts, D. B. and Marais, J. S. C. The utilization by sheep of the proteins contained in the natural grazing during different seasons of the year 415
Myburgh, S. J......... The carotene content of some South African feeds..... 421

SECTION VI.

## Toxicology and Poisonous Plants.

| | | |
|---|---|---|
| De Waal, H. L. | The Senecio Alkaloids. Part 2. Hydrogenation, hydrolysis and structural results of isatidine | 433 |

SECTION VII.

## Chemical Blood Studies.

| | | |
|---|---|---|
| Roets, G. C. S. | Chemical blood studies VIII. A rapid spectroscopic method for (A) the quantitative determination of haemoglobin in blood and (B) its application for the quantitative estimation of haemoglobin in milk, urine, serum or plasma and faeces | 451 |

SECTION VIII.

## Wool Research.

| | | |
|---|---|---|
| Rossouw, S. D. | The origin of sulphur in wool. III. An improved cuprous mercaptide method for the determination of cystine in material low in cystine | 461 |

SECTION IX.

## Poultry.

| | | |
|---|---|---|
| Coles, J. D. W. A. | Conjunctivitis of the domestic fowl and an associated Rickettsia-like organism in the conjunctival epithelium | 469 |

SECTION X.

## Anatomy.

| | | |
|---|---|---|
| Cloete, J. H. L. and Steyn, H. P | Anatomical studies No. 63. An abnormal bovine heart | 481 |
| Jackson, C. and Viljoen, W. C. | Anatomical Studies No. 64. Anomalous course of the left phrenic nerve in a donkey | 489 |

# Section I.

# Protozoology.

NEITZ, W. O. Eperythrozoonosis in cattle 9

*Onderstepoort Journal of Veterinary Science and Animal Industry,*
*Volume* 14, *Numbers* 1 *and* 2, *January and April*, 1940.
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# Eperythrozoonosis in Cattle.

By W. O. NEITZ, Section of Protozoology and Virus Diseases,
Onderstepoort.

## INTRODUCTION.

ADLER and ELLENBOGEN (1934) saw Eperythrozoa in blood smears from a splenectomized calf; these they named *Eperythrozoon wenyoni.* Similar parasites were observed independently by Neitz and Quinlan (1934) in smears from several splenectomized calves. A detailed study of this infection could not be undertaken because under the conditions of the experiments accidental natural infection could not be excluded. Further, the clinical picture in a number of the animals was complicated by concurrent infections of piroplasmosis, anaplasmosis, theileriasis, or spirochaetosis.

## DEFINITION.

Eperythrozoonosis of cattle is an infectious disease, caused by *Eperythrozoon wenyoni*, a small supra- or extracellular blood parasite having a ring, rod, irregular or oval shape, and belonging to the family Anaplasmidae. Infection by the microorganisms may result in the production of a mild fever and a slight anaemia Relapses may occur. The mode of transmission is not known, but it is believed that the vector is a blood-sucking arthropod; probably a louse.

## OCCURRENCE.

Little is known about the geographical distribution of *Ep. wenyoni.* Its occurrence has been recorded by Adler and Ellenbogen (1934) in a splenectomized calf in Palestine, by Neitz and Quinlan (1934) in splenectomized and non-splenectomized cattle in South Africa; by Hering* (1934) in California, U.S.A., by Delpy (1936), in Iran, by Donatien and Lestoquard (1937) in Algeria, and by Nieschulz (1938) in Holland, all in non-splenectomized animals. The infection recorded by Nieschulz was produced with blood imported into Holland from Algiers.

---

* Personal communication.

In South Africa *Ep. wenyoni* has been observed in cattle reared and maintained at Onderstepoort; in cattle bred at Vryburg in the North-West Cape Province subsequent to exposure at Tzaneen in the Northern Transvaal; in a cow at Sabie in the Eastern Transvaal; in a calf at Warmbad in the Northern Transvaal and in an ox at Reitz in the Orange Free State. The latter case was complicated by a concurrent infection of anaplasmosis.

## AETIOLOGY.

### (*a*) *Morphology.*

Neitz, Alexander and du Toit (1934) suggested that the four genera, *Anaplasma*, *Bartonella*, *Eperythrozoa* and *Grahamella*, should be included in the family Anaplasmidae. Although no morphological differences can be detected between *Ep. ovis* and *Ep. wenyoni* it will be seen from the experiments described below that they must be considered distinct species.

When stained with Giemsa the micro-organisms take on a pinkish purple colour. They are approximately 0·3 to 1·5μ in diameter. The typical form is a delicate ring, but ovoid, comma, rod, dumb-bell and tennis-racket forms are quite common (see photomicrographs, Figs. 1-5). At the thick end of the smear the ring-forms predominate, while towards the thin end the rod and comma forms are more common. This distribution is mechanical, and is brought about during the process of drawing the blood film. Apparently multiplication takes place by budding and by fission.

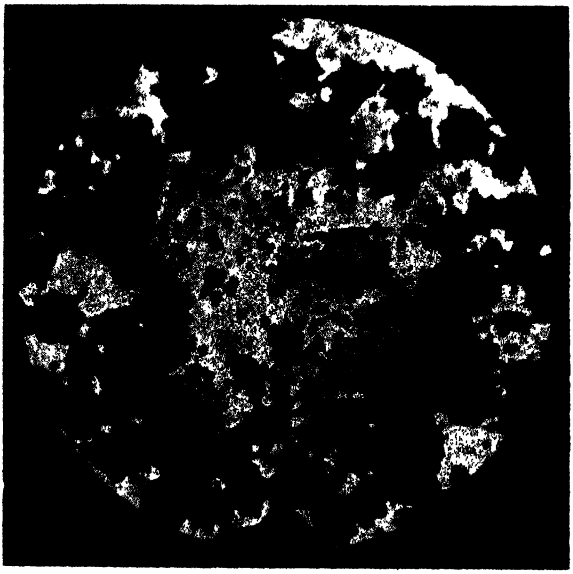

FIG. 1.—*Eperythrozoon wenyoni* in a blood smear from a splenectomized calf; 1,330×.

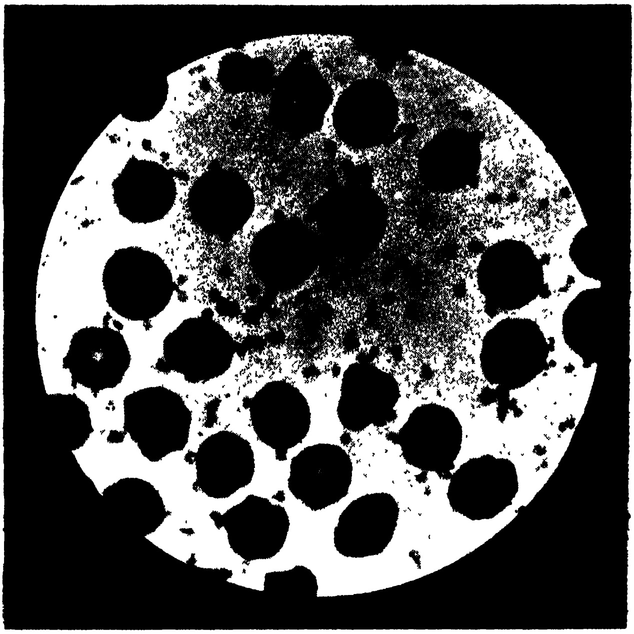

Fig. 2.- *Eperythrozon wenyoni* in a blood smear from a splenectomized calf; 2,000×.

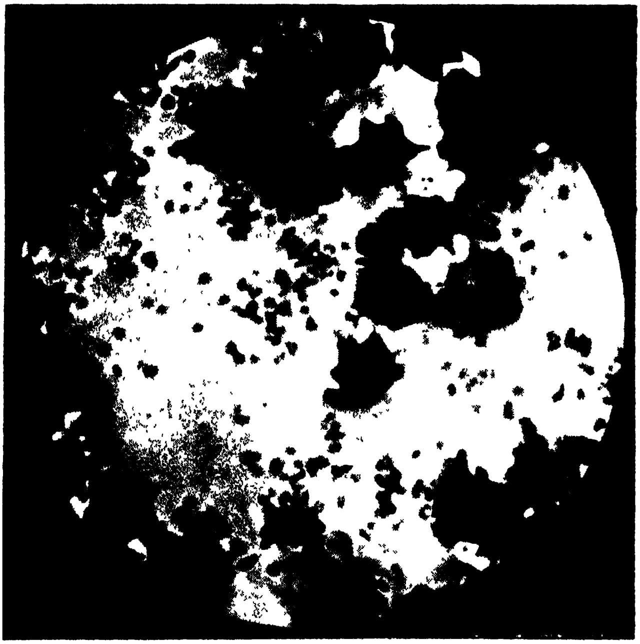

Fig. 3.—*Eperythrozoon wenyoni* in a blood smear from a splenectomized calf; 2,000×.

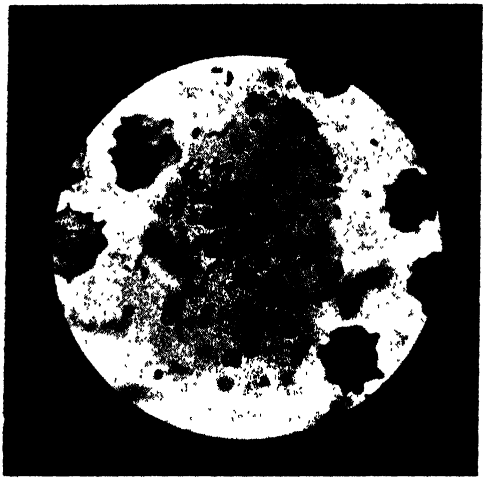

Fig. 4.- *Eperythrozoon wenyoni* in a blood smear from a non-splenectomized calf; 1,500×.

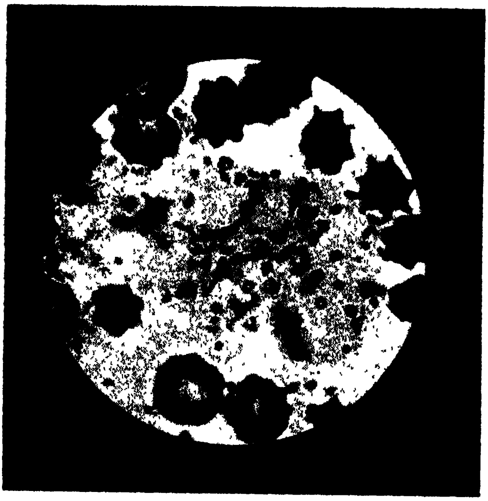

Fig. 5. -*Eperythrozoon wenyoni* in a blood smear from a non-splenectomized calf; 1,500×.

### (*b*) *Localization.*

It is not known whether the distribution of *Ep. wenyoni* in stained smears is a true picture of the distribution of the parasites in the circulating blood. The union between the parasites and host cells is loose, so that it is possible that a large number of free forms may simply be detached during the process of smear preparation. It has frequently been observed that the proportion of supracellular and extracellular forms varies considerably in different preparations made from the same animal at the same time.

### 1. *Supracellular Forms.*

A single parasite may be present on an erythrocyte. On the other hand its entire surface may be dotted with parasites varying in number from 20 to 60. The parasites may be superimposed on each other. Most commonly the supracellular forms are to be found in clusters of 3 to 12 aggregated towards the centre, or the periphery or actually around the circumference of the erythrocyte.

### 2. *Extracellular or Free Forms.*

These forms usually predominate. In thick smears where the erythrocytes are closely packed together the interstices may appear to be filled with a homogeneous mass which stains in a manner similar to the parasites.

## TRANSMISSION.

During the course of some work on protozoon diseases four calves which had been born and bred at the experimental station Armoedsvlakte, Vryburg, were exposed to tick infestation under natural conditions, three at Tzaneen in the Northern Transvaal, and one at Spitzkop in the Eastern Transvaal. These calves were selected for the following reasons:—(1) Careful observation over a number of years has shown that very few ticks are found at Armoedsvlakte, so that the chance of prior tick infestation was very limited. (2) Extensive experimental work has shown that the great majority of cattle from Armoedsvlakte are fully susceptible to anaplasmosis, piroplasmosis, and other tick-borne diseases of South Africa.

The calves became very heavily infested with ticks, chiefly *Rhipicephalus appendiculatus*, *Boophilus decoloratus*, *Hyalomma aegyptium*, *Amblyomma hebraeum*. and *Rhipicephalus evertsi*. So heavy was tick infestation that the animals suffered severely from the direct effects as evidenced by marked swellings of the ears, eyelids and superficial lymphatic glands and development of abscesses. In addition specific infections of *Theileria mutans* and *Spirochaeta theileri* appeared. Subsequently *Ep. wenyoni* were demonstrated. (For detail see Table 4.) From these observations the tentative conclusion appeared warranted that one or more of the species of ticks had transmitted the Eperythrozoan infection. It was then decided to carry out a series of carefully controlled experiments to throw further light on this point.

It is well known that splenectomy of animals harbouring a latent infection of genera of the family Anaplasmidae is followed by their appearance in large numbers in the blood stream. That this observation holds good for the genus Eperythrozoon is apparent from a consideration of the results of splenectomy of a heterogeneous collection of animals detailed in Table 5. It will be seen that in every instance *Ep. wenyoni* appeared subsequent to splenectomy.

To insure the initial susceptibility of the animals to be used in the experiments, four calves which had been born and bred under carefully controlled tick-free conditions were splenectomized. The subsequent history of these animals is tabulated in Table 1. It is seen that two of the four showed a relapse of Eperythrozoonosis after an interval of 40 days, while two remained free for a period of over two months. It must be emphasized that the conditions under which these animals were maintained was such that any possibility of accidental tick infestation may be excluded with every confidence. In addition accidental transmission during the process of preparing blood smears was eliminated by using separate sterile instruments for each animal. On the other hand it was noticed that lice *Bovicola bovis* and *Linognathus vituli* were present in fairly large numbers.

It was concluded therefore that rearing calves under tick-free conditions is no guarantee of their freedom from infection with Eperythrozoa and for experimental work of this nature it is essential to use animals whose full susceptibility is proved by the results of splenectomy, if the conclusions drawn for the experiments are to have any value.

At this stage it was decided to modify the programme of work. Previous experience with tick transmission experiments has shown that to work out the cycle in the invertebrate host large numbers of susceptible animals are essential. Rather than use the only two susceptible bovines available, it was thought that if *Ep. wenyoni* of cattle is identical with *Ep. ovis* of sheep, the work could be completed more easily on a larger number of splenectomized sheep which could easily be made available. Consequently transmission experiments with cattle were temporarily abandoned.

## *Discussion.*

Donatien and Lestoquard (1937) claimed that *Ep. wenyoni* is transmitted by ticks. They obtained adult ticks of an undetermined species of *Hyalomma* from Iran. These ticks were fed on two bulls: 14 days later *Th. dispar* appeared and 8 days later *Ep. wenyoni*. From this they concluded that infection had been transmitted by ticks, but from the observations recorded above it is immediately apparent that the conclusion was not justified, since, in the first place, no attempt was made to determine whether the bulls harboured a latent infection or not. The fact that parasites appeared in the blood stream of calves reared under tick-free conditions subsequent to splenectomy indicates strongly that ticks definitely are not the only transmitters.

The ectoparasites which were common to the calves under the conditions of the experiment were lice, so that the rôle of these arthropods as transmitters must be taken into serious consideration.

Elliot 1936 showed experimentally that the vector of *Eperythrozoon coccoides* of the mouse is the louse *Polyplax serrata*. It is considered that this is the only case where the transmission of an *Eperythrozoon* is supported by adequate experimental data.

## RELATIONSHIP OF *Ep. wenyoni* AND *Ep. ovis*.

It has not been possible to demonstrate any morphological difference between *Ep. wenyoni* and *Ep. ovis*. Neitz (1937) stated that *Ep. ovis* is pathogenic for calves, thus indicating the probable identity of the two species. In view of the more carefully controlled experiments detailed below that statement must now be corrected. A susceptible splenectomized calf 6289 (see Table 1) was given a subcutaneous injection of 10 c.c. blood from a calf 6049, which was passing through a relapse to *Ep. wenyoni* after splenectomy. Parasites were demonstrated intermittently from the 11-55th day after injection. It was therefore concluded that *Ep. wenyoni* may be transmitted to a susceptible calf from an infected calf by the subcutaneous injection of blood. A second susceptible splenectomized calf 6295 received 10 c.c. of blood from a sheep 41839 which was a known carrier of *Ep. ovis*. Parasites were demonstrated intermittently from the 6th to the 34th day after injection and were associated with a marked anaemia (Table 1).

From this experiment it appeared justifiable to conclude that a susceptible calf may be infected by the subcutaneous injection of sheep blood containing *Ep. ovis*. It would therefore appear that the two parasites are species identical. To confirm this conclusion it was decided to transfer the infection from the calf back to susceptible splenectomized sheep bearing in mind that Neitz (1937) had shown that sheep may be infected with *Ep. ovis* by the subcutaneous route. Two splenectomized sheep (Table 2) which had shown no recrudescence of infection after the operation were injected subcutaneously with 5 c.c. of blood from calf 6295. Smears were examined daily for 5 weeks but no parasites were seen. The result of this experiment was so striking that it was deemed essential to continue the investigation.

Three non-splenectomized lambs whose blood had failed to reveal the presence of Eperythrozoa during the previous 7 weeks and 5 splenectomized sheep which remained clean for from 5-10 weeks after splenectomy received injections of cattle blood known to contain large numbers op *Ep. wenyoni* (Table 2). In no single instance did the injection result in infection of the sheep.

The 3 lambs and one of the splenectomized sheep subsequently were found to be fully susceptible to *Ep. ovis;* the remaining 3 sheep were utilized for other experiments. From this it can be concluded that sheep susceptible to *Ep. ovis* are refractory to infection with *Ep. wenyoni.*

## *Discussion.*

**Since conflicting results appear to have been the outcome of the experiments recorded, a careful analysis is essential. The appearance of Eperythrozoa in the blood of a susceptible splenectomized calf subsequent to an injection of blood containing *Ep. ovis* warranted the conclusion that calves are susceptible to the sheep parasite. If this actually was the case it should have been possible to transfer infection from the calf back to susceptible sheep. The attempt failed. Further it was found to be impossible to infect 8 other susceptible sheep with *Ep. wenyoni*. The logical explanation would therefore appear to be that the calf became accidentally infected with *Ep. wenyoni* by some unknown vector, certainly not a tick but possibly a louse, and that**

the appearance of the parasites in the blood stream happened to coincide with the time that they could have been expected after the injection of the infective blood. It is finally concluded therefore that *Ep. wenyoni* and *Ep. ovis* are distinct species infective for cattle and sheep respectively. The experiments serve to emphasize the necessity of exercising the greatest care in planning work of this nature, and of drawing conclusions only after exhaustive investigation.

## PATHOGENESIS.

The Eperythrozoa parasitize the erythrocytes, but it is not clear how destruction is brought about. In non-splenectomized animals a mild or no anaemia has been observed, whereas in several of the splenectomized calves severe anaemia and icterus resulted from the infection. The blood showed a drop in the red cell precipitate obtained on centrifugation, and the red cell count fell as low as 1,200,000 per c.cm. The decrease in the number of erythrocytes commences at the time of the first appearance of parasites. There is also a rise in the leucocytic count up to 37,000 per c.cm. Degenerative and regenerative processes namely anisocytosis, polychromasia, punctate basophilia, reticulocytes, Jolly bodies and normoblasts are seen in stained smears. Erythrophagocytosis is well marked. Haemoglobinuria has only once been observed, viz., in a non-splenectomized bovine, which was reacting to *Ep. wenyoni*, *Th. mutans* and *Sp. theileri*.

## SYMPTOMS.

The symptoms and course of the disease have been studied in a very limited number of non-splenectomized and splenectomized cattle.

### A. *Observations in Non-splenectomized Cattle.*

1. In the experimentally infected cattle mentioned in Table 3 it will be seen that the incubation period varied from 16-22 days. The parasites could be demonstrated microscopically for a period of 1 to 8 days. No relapses were observed in any of the animals. A slight anaemia was observed in two of them. Febrile reactions and clinical symptoms were absent. If daily blood smears had not been examined, the infection would have passed unnoticed.

2. In the cattle mentioned in Table 4 the latent infection of *Ep. wenyoni* was activated by the direct effects of the heavy tick infestation and by the severe *Th. mutans* reaction. The parasites could be demonstrated microscopically for a period of 4-13 days, but relapses were not observed. The severe anaemia and the haemoglobinuria were in all probability also partially due to the theileriasis and spirochaetosis present.

## TABLE 1.

*Splenectomy of Calves reared under Tick-free Conditions.*

| Number of calf. | Date of birth. | Date of splenectomy. | *Ep. wenyoni* appeared after. | Remarks. | Subsequent History. | | |
|---|---|---|---|---|---|---|---|
| | | | | | Injected from. | Date. | Remarks. |
| 6049 | 20/3/34 | 19/11/34 | 40 days | *Ep. wenyoni* seen for 11 days. A slight anaemia resulted from the infection | — | — | — |
| 6050 | 27/3/34 | 14/11/34 | 40 days | *Ep. wenyoni* seen for 11 days. A slight anaemia resulted from the infection | — | — | — |
| 6289 | 27/7/34 | 15/11/34 | — | Blood smears were negative for a period of 75 days | Splenectomized calf 6049 harbouring *Ep. wenyoni* | 10 c.c. blood subcut. | *Ep. wenyoni* could be demonstrated on the 11th—17th, 20th—21st, 28th, 38th—44th and again on the 52nd—55th days after injection. Anaemic changes, namely basophilia, polychromasia, anisocytosis and Jolly bodies were observed in the blood smears. |
| 6295 | 17/8/34 | 15/11/34 | | Blood smears were negative for a period of 75 days | Sheep 41839 harbouring a latent infection of *Ep. ovis* | 10 c.c. blood subcut. | Eperythrozoa were seen on the 6th–8th, 14th–15th, 24th, and 26th–34th days after injection. At the time of the first appearance of parasites the red blood count was 10 × 10$^6$ and the white blood count 8,400. A progressive anaemia developed and on the 37th day the red blood count dropped to 1·2 × 10$^6$ and the white blood count rose to 37,300. The blood showed basophilia, anisocytosis, polychromasia, normoblasts, Jolly bodies and erythrophagocytosis. The anaemia gradually disappeared and on the 60th day the red blood count was 5·47 × 10$^6$, and the white blood count 13,400.<br>Blood from this calf was injected into two splenectomized sheep 41473 and 41474 mentioned in Table 2. |

# TABLE 2.

## *Attempted Transmission of* Eperythrozoon wenyoni *to Sheep.*

| | | *Eperythrozoon wenyoni* infection | | | | *Eperythrozoon ovis* infection. | | | |
|---|---|---|---|---|---|---|---|---|---|
| Number of sheep | Date of birth | History | Injected from | Dose of blood i v | Result | Injected from | Dose of blood i v | Incub period | Result |
| 41214 | 9 8 34 | Susceptible nonsplenectomized lamb | Splenectomized calf 5425 actively infected with *Ep wenyoni* and *Anaplasma centrale* | 5 c c | Blood smears were examined daily for a period of 7 weeks but *Ep wenyoni* did not appear | Sheep 41588 a carrier of *Ep ovis* | 5 c c | 4 days | *Ep ovis* present from 4th–15th day Parasites were very frequent Lamb died on the 17th day, and at autopsy there was a generalized anaemia and icterus, a tumour splenis, an acute fibrinous pericarditis and pleuritis. |
| 41592 | 10, 10 34 | Susceptible nonsplenectomized lamb | Splenectomized calf 5425 | 5 c c | Blood smears were examined daily for a period of 7 weeks but *Ep wenyoni* did not appear | Sheep 41588 a carrier of *Ep ovis* | 5 c c | 4 days | *Ep ovis* present from 4th–10th day, i e , until death Parasites were frequent Lamb died on the 10th day and at autopsy there was a hydropericard, subepicardial haemorrhages, oedema of the pharangeal region, tumour splenis, and hyperplasia of the malpighian corpuscles. |
| 41593 | 10, 10 34 | Susceptible nonsplenectomized lamb | Splenectomized calf 5425 | 5 c c | Blood smears were examined for a period of 7 weeks but *Ep wenyoni* did not appear | Sheep 41588, a carrier of *Ep ovis* | 5 c c | 4 days | *Ep ovis* present from the 4th–8th day, i e , until death. Lamb died on the 8th day and at autopsy there was a hydropericard, hydrothorax ascites, fibrinous peritonitis and a catarrhal enteritis |
| 41475 | 10 9 34 | Susceptible splenectomized sheep | Splenectomized calf 6289 actively infected with *Ep wenyoni* | 5 c c | Daily blood smears were examined for 5 weeks but *Ep wenyoni* did not appear | — | — | — | — |
| 41476 | 10 9 34 | Susceptible splenectomized sheep | Nonsplenectomized calf 7049 actively infected with *Ep wenyoni* | 10 c c | Daily blood smears were examined for 11 weeks but *Ep wenyoni* did not appear | Sheep 47040 carrier of *Ep ovis* | 10 c c | 8 days | *Ep ovis* appeared in large numbers and marked anaemic changes were observed in the blood smears |

TABLE 2 (*continued*).

| Number of sheep. | Date of birth. | *Eperythrozoon wenyoni* infection. | | | | *Eperythrozoon ovis* infection. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | History. | Injected from. | Dose of blood I.V. | Result | Injected from. | Dose of blood I.V. | Incub. period. | Result. |
| 41479 | 10/9/34 | Susceptible splenectomized sheep | Nonsplenectomized calf 7075 actively infected with *Ep. wenyoni* | 20 c.c. | Daily blood smears were examined for 10 weeks but *Ep. wenyoni* did not appear | — | — | — | — |
| 41486 | 13/9/34 | Susceptible splenectomized sheep | Nonsplenectomized calf 7075 actively infected with *Ep. wenyoni* | 20 c.c. | Daily blood smears were examined for 10 weeks but *Ep. wenyoni* did not appear | — | — | — | — |
| 41473 | 10/9/34 | Susceptible splenectomized sheep | Splenectomized calf 6295 that reacted to Eperythrozoa after receiving blood from a sheep harbouring *Ep. ovis.* (See Tbl. 1.) | 5 c.c. | Daily blood smears examined for a period of 5 weeks but no parasites appeared | — | — | — | — |
| 41474 | 10/9/34 | Susceptible splenectomized sheep | Splenectomized calf 6295 that reacted to Eperythrozoa after receiving blood from a sheep harbouring *Ep. ovis.* (See Tbl. 1.) | 5 c.c. | Daily blood smears were examined for a period of 5 weeks but no parasites appeared | — | — | — | — |

## TABLE 3.

*Observations in Non-splenectomized Cattle.*

| No. of animal. | Expt. No. | Date of birth. | Date of injection. | Injected from. | *Ep. wenyoni* seen on. | Remarks. |
|---|---|---|---|---|---|---|
| 7049 | S 5856 | 4/1/36 | 27/11/36 | Cow 6440...... | 20th-26th day. | Parasites fairly frequent and a mild anaemia developed. A febrile reaction was not observed. |
| 7075 | S 5856 | 14/2/36 | 14/1/37 | Calves, 7007, 7009 and 7010 | 16th-19th day. | Parasites very rare. No anaemia and no febrile reaction was observed. |
| 7191 | S 6544 | 10/6/36 | 23/5/37 | Heifer 7168.... | 19th day only. | Parasites very rare. No anaemia and no febrile reaction was observed. |
| 7367 | S 6544 | 3/4/37 | 7/10/38 | Cow 6438...... | 19th-20th day. | Parasites very rare. No anaemia and no febrile reaction was observed. |
| 7411 | S 6544 | 5/7/37 | 7/10/38 | Cow 6438...... | 19-22nd day... | Parasites very rare. No anaemia and no febrile reaction was observed. |
| 7468 | S 5946 | 10/11/37 | 26/9/38 | Heifer 7009.... | 22nd day only. | Parasites very rare. No anaemia and no febrile reaction was observed. |
| 7467 | S 5856 | 8/11/37 | 9/5/38 | Heifer 7170.... | 20th-27th day. | Parasites rare. Slight anaemia but no febrile reaction was observed. |

## TABLE 4.

*Observations in Non-splenectomized Cattle exposed to Tick Infestation.*

| No. of calf. | Date of birth. | Origin. | Period of exposure. | Locality. | Species of ticks. | Period of febrile reaction. | Koch's bodies. | *Th. mutans* seen on. | *Ep. wenyoni* seen on. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|
| 6901 | 16/2/27 | Armoedsvlakte | 21/2/38–7/3/38 | Tzaneen | Chiefly *Rh. appendiculatus*, and to a lesser extent *B. decoloratus*, *Hyal. aegyptium*, *Amb. hebraeum*, *Rh. evertsi* | 1/3/38–12/3/38 | 9/3/38–11/3/38 | If animal had not died *Th. mutans* would have appeared | 16/3/38–19/3/38 | A second febrile reaction was seen from 18/3/38–24/3/38. On 24/3/38 ox showed a marked haemoglobinuria and icterus. No blood parasites other than *Ep. wenyoni* and *Sp. theileri* were seen during the second febrile reaction. Calf received 50 c.c. of a 1% solution of Trypan blue on the 24/3/38, but died the same day. |
| 6725 | 23/11/36 | Armoedsvlakte | 21/2/38–7/3/38 | Tzaneen | As in the case of 6901 | 2/3/38–31/3/38 | 10/3/38–17/3/38 | 28/3/38 | 11/3/38–23/3/38 | *Spirochaeta theileri* was seen on 28 and 29/3/38. Anaemia, i.e., basophilia, polychromasia anisocytosis was observed. Animal recovered. |
| 6732 | 30/11/36 | Armoedsvlakte | 21/2/38–7/3/38 | Tzaneen | As in the case of 6901 | 1/3/38–7/3/38 | Although the reaction was similar to that of 6725 Koch's bodies were not seen | 18/3/38 | 16/3/38–26/3/38 | Anaemia, i.e., basophilia, polychromasia, anisocytosis was observed. Animal recovered. |
| 5794 | 22/11/34 | Armoedsvlakte | 22/4/36–26/9/37 | Spitzkop | Chiefly *Rh. appendiculatus* | No febrile reaction | — | — | 23/11/36 | Parasites very frequent. Smears examined on one day only, and nothing can, therefore, be said as to whether an anaemia developed or not. |

### B. *Observations in Splenectomized Cattle.*

1. In the four calves which reacted to a pure infection of *Ep. wenyoni* the following symptoms were noticed:—

A relapse to *Ep. wenyoni* was seen 40 days after splenectomy in calves 6049 and 6050 mentioned in Table 1. The parasites were demonstrated microscopically for a period of 11 days. A slight anaemia resulted from the infection, but no febrile reaction and no clinical symptoms were observed.

In the artificially infected calf 6289, *Ep. wenyoni* appeared on the 11th day and was demonstrated microscopically for a period of 8 days. Four parasitic relapses were observed after the primary reaction. Anaemia, icterus and a mild febrile reaction but no other clinical symptoms were observed.

In the naturally infected calf, 6295, mentioned in Table 1, *Ep. wenyoni* produced severe anaemia and icterus. Three relapses followed the primary appearance of parasites. A febrile reaction, inappetence and general weakness were observed, but the animal recovered without treatment.

2. The three cattle mentioned in Table 5 were inoculated with blood, which at the time of bleeding contained *Piroplasma bigeminum* and *Anaplasma centrale*, but which had been stored at room temperature for periods of 48 and 72 hours. Reactions due to both the mentioned parasites were observed in ox 5435 which had received 48-hour old blood, whereas the two heifers 5425 and 5432 which received 72-hour old blood reacted only to *A. centrale*. The splenectomy caused a recrudescence of the mentioned parasites, as well as that of *Ep. wenyoni*, which had not been previously observed in any of the animals Severe anaemia was noticed in all the animals. It was possible by timely intervention ,to control the reactions of *P. bigeminum* with trypan blue and acaprin, and that of *Ep. wenyoni* with neosalvarsan.

The behaviour of the various parasites in the animals is extremely interesting. It will be seen from Table 5 that the calves were reinjected at a later date with blood which contained *P. bigeminum A. centrale* and *Th. mutans*. Daily blood smears of cattle 5425 and 5435, were examined for a period of 5 years after splenectomy.

(*a*) *P. bigemium* was harboured by cattle 5425 and 5435 for a comparatively short period. Ox 5435 was reinfected and it was necessary to control the reaction with acaprin. This animal lost its infection again.

(*b*) *A. centrale* and *Th. mutans* were demonstrated regularly in blood smears for a period of 5 years. It appears that cattle remain carriers of these parasites indefinitely.

(*c*) In heifer 5425 thre relapses of *Ep. wenyoni* were observed up to 61 days after the primary reaction, but no further relapses were observed during the subsequent 5 years. In ox 5435 on the other hand, *Ep. wenyoni* was seen again 1,456 days after the primary reaction, but it is not clear whether this finding was a relapse, or whether it was due to a reinfection.

## PROGNOSIS.

In the limited number of animals under observation it has been found that the course of the disease is extremely mild in non-splenectomized cattle. There was no mortality.

## PATHOLOGICAL ANATOMICAL CHANGES.

As no animals died or were slaughtered, an opportunity to study the pathological changes did not present itself.

## DIAGNOSIS.

The diagnosis is dependent upon the microscopic demonstration of the parasites in the blood smears. In cases of anaemia and icterus the possibility of Eperythrozoonosis must be taken into consideration.

The presence or absence of a latent infection can be determined by subinoculating blood into susceptible animals.

## TREATMENT.

Since this infection produces mild or no symptoms in non-splenectomized animals treatment is unnecessary. Occasion, however, may arise where treatment has to be undertaken. In such cases the use of neosalvarsan and the arseno-stibio compound Std. 386 B, which have been shown to act specifically on *Ep. ovis* by Neitz (1937) are recommended.

Neosalvarsan has been used in two cattle mentioned in Table 5. In heifer 5425, weighing approximately 150 Kg., 0·9 gms. of neosalvarsan caused the parasites to disappear after 30 minutes. A reappearance of the parasites was observed 15 days later, which indicates that sterilization was not brought about. In the other heifer, 5432, weighing approximately 180 Kg., 1·35 gms. of neosalvarsan were administered. The parasites in this animal could still be demonstrated in small numbers after 24 hours, and a second dose of 0·9 gms. was given. The blood smears which were examined subsequently after a period of 112 days were free of parasites. No attempts were made to ascertain whether sterilization resulted from the treatment in either of the above cases.

## IMMUNITY.

From the observations on splenectomized and non-splenectomized calves, it appears that the immunity is due to a " labile infection " or an " immunitas non sterilisans ", which leads to an equilibrium between parasites and the host.

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# Section II.

# Virus Diseases.

DE KOCK, G., ROBINSON, E. M. AND KEPPEL, J. J. G. Swine fever in South Africa ... ... ... 31

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# Swine Fever in South Africa.

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## INTRODUCTION.

EXTENSIVE outbreaks of swine fever amongst pigs from 1933 onwards both in the Transvaal and Cape Province afforded an opportunity of further observations and experiments and of reviewing the whole swine fever problem in the Union of South Africa.

In the latter part of 1933 a number of very severe outbreaks of an infectious disease of pigs occurred in the Western Province and in the Transvaal. In the latter province the disease was mainly confined to the Witwatersrand area. Difficulty was experienced in establishing the true nature of the disease. It was at first thought to be of the nature of a bacterial infection, but early in 1934 cases were encountered in an extensive outbreak in Johannesburg which proved beyond doubt that the disease was swine fever.

### (A) SWINE FEVER IN THE WITWATERSRAND AREA (JOHANNESBURG).

Since 1933 a number of outbreaks occurred in this area, some of which were recurrences on the same farm. In the first of these outbreaks at the Lombardy Estate the owner had about thirty pigs all of which died. The symptoms shown by the pigs were high fever followed by death in two to three days. At post-mortem there was swelling of the spleen, haemorrhagic gastro-enteritis and in one case haemorrhages in the kidney. One of the pigs brought to Onderstepoort showed lesions of an acute septicaemia, with splenic enlargement, haemorrhages in the kidneys and a haemorrhagic condition of the periportal lymphatic glands. A pig inoculated with blood from this case died in 72 hours with lesions of acute swine fever.

Another farm in the area, the Cairngorm Estate was apparently infected from the one previously mentioned. In this outbreak the Government Veterinary Officer described reddening of the skin of the ears and abdomen, haemorrhagic gastro-enteritis, haemorrhages in the kidneys and a reddish black colour of the mesenteric glands. This outbreak was not confirmed by subinoculation into susceptible pigs.

In February, 1934, an extensive outbreak occurred on the Savoy Estate, amongst about two thousand pigs. An infectious disease had occurred in October, 1933, but the mortality was attributed by the owner to a pneumonia and was not reported. The whole stock of pigs was sent to the abattoir and after disinfection, restocking took place six weeks later. No further mortality occurred until February, 1934, when about fifty pigs died within a few days. Many of the pigs died within twelve to twenty-four hours of showing symptoms. A wobbling and uneven gait was noticed. A characteristic symptom was the occurrence of reddish patches on the body and legs. In some cases death occurred suddenly without symptoms having been noticed. Bloodstained mucus was seen issuing from the nose. In one pig the ears were very red and swollen. Small haemorrhages of a bluish red colour could be seen under the skin of the body and on the face, causing bleeding at the inner canthus of the left eye. In another pig haemorrhages were seen under the skin of various parts of the body, most marked round the eyes which were swollen.

In this outbreak the following lesions were encountered:—

(*a*) Multiple irregularly circumscribed haemorrhages in the skin from ½—2 cm. increasing to large sugillatious-like areas of the subcutaneous connective tissues, chiefly over the abdomen near the pubis, shoulders and on to the limbs.

(*b*) Extensive haemorrhages and marked swelling of lymphatic glands, especially those of the periportal region, resembling a cluster of very large grapes, and in one case leading to rupture and haematoperitoneum.

(*c*) Multiple haemorrhages into the serosa of parts of the intestines. In one case there were extensive diffuse heamorrhages on the epicardium and endocardium of the left ventricle.

(*d*) Kidneys showed slight degenerative changes and in some, small infrequent petechiae. In one case there was extensive diffuse haemorrhage of the kidney medulla in the vicinity of the pelvis.

(*e*) In every case small consolidated areas were seen in the cardiac lobes of the lung while the rest of the lung was normal. In one case it was complicated by multiple haemorrhages varying from ·5—1 cm. in diameter.

(*f*) Stomach and intestines in some showed slight catarrh with patches of hyperaemia, while in others patches resembling haemorrhages occurred in the submucosa. In all cases except one there was light to acute hyperaemia and swelling of the ileo-caecal valve with early to older ulcerations varying from ·2 to 1 cm. in diameter (probably *Balantidium infection*).

(*g*) Spleen only showed a moderate tumor splenis and in some there were raised reddish areas while the lymphoid tissue was prominent.

(*h*) The wall of the gall bladder was markedly thickened and in a few cases contained blood.

Defibrinated or citrated blood from four of these pigs was injected into pigs at Onderstepoort with positive results. The strain of swine fever virus obtained from this outbreak was used in most of the experiments at Onderstepoort.

## (B) SWINE FEVER IN THE NORTHERN TRANSVAAL.

In the routine examination of carcases of pigs at the Johannesburg abattoir at the time when the Johannesburg outbreaks occurred in 1934, cases were met with in which there was no clinical evidence of the disease, whereas changes in the lymphatic glands strongly suggestive of swine fever were encountered. In a few instances inoculation of material from these pigs set up swine fever. An attempt was made to trace the origin of infection in some of these cases, but without success. Inspections were carried out in a number of districts in the Transvaal but nothing resembling swine fever could be traced. In some cases blood or organs from pigs which had died on farms were used for inoculation into susceptible pigs, but without positive results.

During the year 1934-35 no cases were reported from Potgietersrust, Waterberg and Zoutpansberg, whereas in 1935-36 one outbreak occurred in Potgietersrust, two in Waterberg and three in Zoutpansberg. During 1937 two outbreaks were diagnosed on two adjoining farms in the Pietersburg district. During 1938 two outbreaks again occurred in the Pietersburg district. In addition there were 2 suspected outbreaks in the Potgietersrust district but these were not confirmed because all the pigs had succumbed. This small number of active infections is probably not a true reflection of the real incidence of the disease in the Northern Transvaal, because apart from the difficulty caused by the fact that wild pigs are natural carriers of swine fever, the control of the disease in domestic pigs is rendered most difficult in that area. From a preliminary census it would appear that in these northern districts there were probably more than 20,000 pigs. These are owned by about 900 European and 1,800 natives. Only about 15 per cent. of these pigs are well bred, whereas 25 per cent. run free and are not under control. The possibility therefore exists that such pigs may from time to time come into contact with wild pig carriers and become infected. These sporadic outbreaks in Northern Transvaal clearly show the need for the present quarantine restrictions. Pigs from there are either allowed to the quarantine section of an approved abattoir for immediate slaughter or in the case of well bred pigs under proper control " a system of quarantining out " is permitted.

## (C) SWINE FEVER IN THE WESTERN PROVINCE.

A disease with high mortality was reported in October, 1933, at the Imperial Cold Storage, Gouda, Tulbagh district, in pigs for slaughter. At first arsenical poisoning was suspected, but analysis of the organs gave negative results. From blood samples *B. suipestifer* was isolated but a vaccine made did not have any protective action. The blood inoculated into pigs at Onderstepoort produced symptoms of an acute septicaemia with death in three to four days. In these experimental pigs an organism of the *Pasteurella type* was found, and a form of haemorrhagic septicaemia was suspected. Subsequently, however, filtered blood produced similar cases and the conclusion arrived at was that the disease was due to the virus of swine fever.

The infection was probably introduced by pigs from Johannesburg. The Gouda outbreak established a focus of infection for the surrounding districts. Infection broke out on the farm Onverwacht, Wellington, probably introduced by infected pigs' heads and feet purchased by coloured labourers from Hiscocks Bacon Factory at Wellington, which had become infected probably also by pigs introduced from the Transvaal. The spread from these centres was at first thought to be limited owing to the isolation of the infected pigs at the Bacon Factory and Gold Storage. Unfortunately the disease had spread further than was realised. Early in 1934, a further centre was discovered on the outskirts of Cape Town in the pigs of a dealer, but it was possible to dispose of the pigs. Towards the end of 1934 a big outbreak occurred in Retreat, a suburb of Cape Town, and about 300 pigs died. This outbreak was fortunately localized as no distribution of pigs took place. In January to March, 1934. reports were received of a disease in pigs with a high mortality, from a village called Halfmanshof near Gouda and from Riebeek West in the Malmesbury district. In March, 1934, a severe outbreak occurred at a farm Fruit Grove, Wellington. The owner got rid of his pigs not yet affected to a dealer, who lost the majority of them. A farmer at Paarl bought manure from the Paarl Abattoirs and his pigs became infected, heavy losses resulting. By this time the disease had become widespread and quarantine measures with prohibition of movements of pigs were introduced. A large area of country was involved including Cape Town, Wynberg, Simonstown, Belville. Wellington. Tulbagh, Stellenbosch, Malmesbury, Moorreesburg, and Piquetberg, i.e., an area of about 600 square miles.

A natural mountain barrier with only a few passes hindered the spread of the disease to the north and the disease remained confined almost exclusively to the districts mentioned, on the southern aspect of the mountain. The northern mountain barrier was, however, twice penetrated by the disease. In one case the infection apparently went via the Bain's Kloof Pass and Mitchell's Pass to Prince Alfred's Hamlet, Ceres. This outbreak was suppressed at once and did not spread. The nearest infection by road was fifty miles away. The other extension occurred through a pass known as The Rest, to Clanwilliam district, and a farm on the Piquetberg-Clanwilliam road became infected. The outbreak was 70 miles from the nearest infection in the Malmesbury district. The pigs on the farm were slaughtered out and no further outbreaks occurred in the district.

In the infected areas the farming is mainly fruit and wine production with pigs as a sideline to provide fresh meat for coloured labourers. In the Malmesbury and Piquetberg areas grain farming is the main occupation, pigs being allowed free range on the stubble and grasslands. These areas are all closely settled so that spread of infection was facilitated.

During the year 1936, after a quiescent period of some months, the disease again made its appearance in this province under some mysterious circumstances. There was no evidence that infection had been introduced from outside and the indications were that the recurrent outbreaks had their origin in local foci of infection where the disease had remained latent since the 1934-35 outbreak. The outbreaks during the year 1936 occurred as follows: Wellington 2, Caledon 1, Franschhoek 1, and Worcester 1. These infections involved a total of 148 pigs which were all slaughtered off. In respect of the Caledon outbreak (*vide* file 18/16/1 of 1936) the infection extended from Elgin to Villiersdorp.

Several factors apparently contributed to the spread of the disease in the Western Province. Speculators disseminated the disease by the movement of pigs from one place to another, very often in vehicles from which the excreta infected clean premises. A further factor contributing to the spread of infection was the local custom of distributing portions of meat from a carcase to the neighbours. Owing to the custom of using manure from the abattoirs for fertilizing purposes in vineyards and orchards, infection was apparently also spread in this way. Pigs are often allowed to have free range in the vineyards and orchards and not many are kept in styes continuously. The movement of coloured labourers with food supplies such as pig products from farm to farm in the course of harvesting may also have been a source of setting up new infections.

In the control of the infection in the Western Province an attempt was made to forward as many as possible of the healthy pigs on the infected farms to the abattoirs to minimize financial loss. Farmers with farms in contact with infection were advised to evacuate their pigs to the abattoirs to create buffer farms without pigs. Five abattoirs, conveniently situated, were selected for this slaughtering under direct veterinary supervision. Buffer areas were created by keeping pigs on farms adjoining infected ones in styes and temperaturing weekly while a strict census was kept at the same time. The creation of buffer zones enabled many unsuspected outbreaks to be found. The buffer zones extended to those farms situated within ten miles of the in-contact zone. Early in 1935 the disease had burnt itself out in the areas where it had first appeared and when the disease was arrested in March, 1935, about 1,500 farms were under observation.

The disease did not progress as a wave of infection but more often appeared at farms remotely distant from other outbreaks. In some cases the spread was from farm to farm but long jumps were frequent. In the wheat-lands where the pigs ranged freely on the stubble, the spread was very rapid.

A remarkable instance of the spread of infection from a "carrier" occurred on a farm in the Piquetberg area. The farm was infected in July, 1934, when the disease was raging in the area. Nine pigs survived the outbreak one of which was a sow which produced a litter and the sow and young pigs were kept in isolation. When the pigs were four to five months old it was thought that it would be safe for them to mix with the survivors, but when they were allowed to do so they all died of swine fever, seven months after the original outbreak. Pigs from two of the adjoining farms where the disease had not broken out were allowed to mix with the survivors as well and an outbreak amongst them was the result.

In connection with the carrier question two interesting outbreaks of swine fever occurred in 1939 in the Piquetberg district of the Western Province. The first occurred in April (O.P. file 18/61/1 of 1939) on a farm where the disease appeared in 1934 and after a heavy mortality was slaughtered out. In spite of every effort being made to trace the source of the 1939 infection it remained obscure until a second outbreak occurred on an adjoining farm in October, 1939, and a connection between the two was established. In both the outbreaks the diagnosis was confirmed by histopathological examination and subinoculation into pigs, and paratyphoid was excluded. It was eventually found that a mortality occurred every year about October on the farm where this second outbreak was discovered, but it had not been reported and it would appear that carriers probably existed. A pig from this second farm had been sent to the first farm some months previously and a connecting link between the two was thus established.

These outbreaks are remarkable in this way that since the epizootic which ended in 1935 there have been no further outbreaks in that vicinity until 1939 in spite of not infrequent inspections by officers of the department. It is not clear how this virus was maintained on this infected farm and remained localised for such a considerable period without setting up new outbreaks in the neighbourhood. An investigation is being carried out to ascertain whether other domestic animals such as cattle and sheep may have been carriers of the virus. Recenty Zichis (1939) showed that hog cholera virus was transmitted to sheep both by intravenous injection and cohabitation with infected pigs. Although the virus produced inapparent infection in sheep their blood was pathogenic for at least 21 days following infection.

The slaughter out policy adopted by the Department (see control measures: Appendix VIII) proved a successful method of stamping out the disease. It brought the active outbreaks to a close in March, 1935. Attention was then directed to the " carrier element " namely the surviving pigs as a potential source of reinfection. Steps were taken to ascertain the number of surviving pigs in the gazetted areas and to dispose of them with a view of preventing recurrence of infection from this source. This offered a problem that was not easy of solution. Efforts were directed towards evacuation of surviving pigs to one of the approved abattoirs from:—

(a) Outbreaks that occurred at Gouda and Wellington in October and November, 1933, to the date of Government Notice No. 616 of 11.5.1934 and which were not reported.

(b) Known outbreaks from the date of the publication of the first prohibition order (Government Notice No. 616 of 11.5.1934) to the application of the slaughter out policy.

In carrying out the slaughter policy in relation to these surviving pigs an attempt was made in all cases to obtain the goodwill of the farmers concerned. Where possible time was allowed to fatten pigs and allow sows to farrow and wean the piglets. The danger of the carrier element was appreciated by the Farmers' Association and sub-committees were formed and were remarkably helpful in discovering unknown infections and getting the pigs evacuated.

From the initial outbreaks in 1933 to the commencement of the slaughter out policy (December, 1934) about 11,000 were involved and of these more than 8,000 died and about nineteen hundred were evacuated to the Abattoirs. There were 862 survivors left over from the outbreaks and all were slaughtered. Compulsory slaughter was only enforced in three instances, which speaks well for the goodwill of the farmers. The slaughter policy was usually applied on a farm before many pigs had died and in eighty-two outbreaks there were only about 328 deaths from the disease itself. A total of 3,610 pigs was destroyed between December, 1934, and June, 1935, with a valuation of about £1,638, representing compensation at a quarter of the actual value.

## COMMENTS ON SYMPTOMATOLOGY.

Steyn (1928) mentions that farmers in the portion of the Transvaal where the disease was first reported, described it as affecting animals of all ages. The disease was sudden in onset and the animals were noticed to be dull, breathing heavily, grinding the teeth and foaming at the mouth. Death might occur within twenty-four hours of the first symptoms but some pigs remained sick for several days, showing a swaying gait. Affected pigs rarely recovered, but if they did they were immune but might develop a further attack later which was usually not fatal. In his own experiments Steyn found the average incubation period to be two days but it varied from thirty-six hours to four days. The temperature rose to between 105° and 107° F. but occasionally reached 108° F. Towards the end the animals became comatose and the temperature dropped to subnormal. In about 50 per cent. of cases he noticed bronchitis sometimes associated with broncho-pneumonia, but a cough was rarely noticed. Breathing was laboured and the pulse rate was sometimes 180 to the minute. Occasionally diarrhoea was noticed with blood in the faeces, but more commonly the faeces were hard and dry. When walking the pigs showed an arched back and staggering gait.

Walker (1933) in his article on East African Swine Fever describes symptoms almost identical with those mentioned by Steyn. In addition he mentions cyanosis of the skin, ears, hairless parts of the body such as the under side of the abdomen, and insides of thighs and fore legs.

In his experimental work which covered at least 200 animals the average incubation period was three and a half days and the duration of the reaction four days. Montgomery (1921) had two cases which lived for fourteen days.

Other symptoms mentioned by Walker are vomiting in some cases and abortion in pregnant sows. Vomiting as a symptom in the African disease was noticed by Steyn in an outbreak which he investigated after the publication of his original article.

During the recent outbreaks in the Union, the course of the disease has been very similar to that described by Steyn (1928) and Walker (1933). In the earlier reports from the Western Province, it was stated that many pigs were found dead in the morning without having been noticed to have been sick. The majority, however, lived for two or three days. Blood was noticed in the feaces in some cases and was seen to be oozing from the nose and anus after death in others. In white pigs dark red patches were seen on the ears and under the abdomen. Swelling of the ears was noticed in some cases and the eyes were very bloodshot.

In the Witwatersrand outbreak some of the pigs showed haemorrhages of a bluish red colour under the skin of the body and face. Some of these involved the eyes causing bleeding from them. A number of the pigs were described as having died suddenly without showing signs of illness previously and others died after a very short illness. The history was again very similar to that previously described. A number of pigs, however, recovered but they remained in poor condition and showed a scaly condition of the skin.

During the slaughtering out in the course of the eradication campaign in the Western Province, the opportunity was afforded to examine a few recovered animals, some of which were known to have shown symptoms at the time of the outbreak a few months previously. Eight of these cases were examined. Six of them were in excellent condition and apart from slight evidence of swelling of the joints were quite normal in appearance. One of the others was in poor condition and showed marked swelling of the joints. Another showed poor condition with slight swelling of the joints.

In the recent experiments carried out at Onderstepoort the great majority of the cases produced have been acute. The most obvious symptom noted besides the severe hyperthermia (temperature up to 108° C.) is weakness in the hindquarters shown by swaying gait. The average incubation period has been three days and the duration of the visible illness just over three days. The shortest incubation period has been between thirty-six and forty-eight hours. In some of the cases produced by the blood of recovered pigs the incubation period has varied from five days up to even twenty-two days. The addition of swine fever antiserum delayed the reaction up to eleven days in one case and eighteen days in another.

These long incubation periods are unusual and never seem to occur with material from actively infected cases except if antiserum be added to the virus.

The duration of the disease has usually been three to four days, but periods of seven to fourteen days have occurred. Only two pigs have survived out of over one hundred experimental animals. In both these cases recovery was slow and the temperature fell gradually to normal over a period of one to two weeks. In one case constipation was very marked for about a week after the temperature fell to normal but in the other case recovery was uneventful. This latter pig was tested two months after recovery with a virus from a different source to that with which it had previously been inoculated but showed no reaction. The control pig died on the sixth day after inoculation from acute swine fever.

## PATHOLOGICAL CHANGES IN ACUTE CASES.*

In acute cases general changes such as loss of condition as a result of the disease are almost unknown, in fact the animals which succumb are frequently reported as found dead without previously having been noticed sick. Rigor mortis sets in early.

### INTEGUMENT.

The skin almost invariably has a patchy or diffuse purplish colour (cyanosis) which naturally is more striking in light coloured animals, but can be seen even in black animals, e.g., in the axilla and other parts covered by thin skin. More rarely there may be isolated single or multiple irregular, small dark red patches or spots up to one or two cm. in diameter (see Fig. 1). These usually have a raised appearance covered with tense, shiny epidermis and are distributed particularly on the abdomen. Microscopically one finds engorgement and stasis of the smaller blood vessels and capillaries to account for the cyanotic appearance.

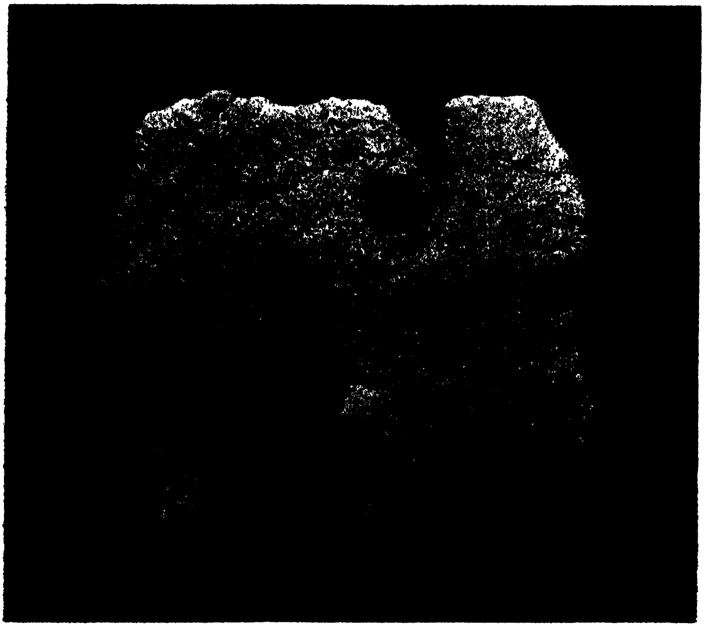

Fig. 1.—Skin showing multiple haemorrhages.

Endovascular hyalinisation and thrombosis can be seen in some cases and, when advanced, leads to localised blood extravasation into the cutis. Other evidence of necrosis, such as karyorrhexis and rarely total disintegration with secondary infection, may be seen according to circumstances.

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(NOTE.—* The histological examination was carried out by Dr. A. D. Thomas, of the Pathological Section, Onderstepoort.)

## ABDOMEN.

As the animals feed well till near the end, the abdomen is usually well filled and presents no great departure from the normal. The peritoneal cavity may contain a variable amount of clear fluid, which sometimes may be somewhat turbid or show fibrinous tufts and strands. The peritoneum is usually smooth and glistening. At times, however, there may be ecchymoses and even extensive reddening with or without fibrinous adhesions.

## THORACIC CAVITY.

The thoracic fluid is usually slightly increased and may reach a considerable amount where pulmonary oedema is marked. On occasion a turbid, almost milky exudate may be present, in which fibrinous shreds may be seen.

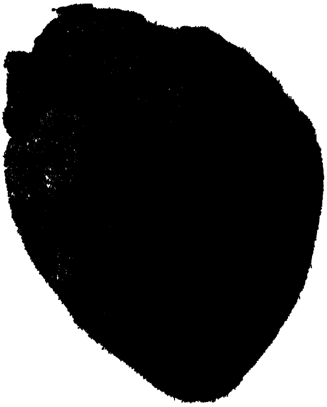

Fig. 2.—Heart. (Spec. No. P.S. 14742.) Extensive subepicardial haemorrhages. ×½.

## HEART.

The pericardial sac often contains an increased amount of clear watery fluid. At times the fluid may be turbid even to the point of being milky, when fibrinous strands and adhesions may form important constituents of the exudate.

Sub-epicardial and sub-endocardial ecchymoses are not infrequent and on occasions may be very extensive and confluent. (See Fig. 2.)

Haemorrhages of variable extent are also to be seen in the substance of the myocard. The endocardium, valves and atria do not as a rule present any changes. The haemorrhages in the myocardium can usually be found associated in histological sections with vascular obstruction (thrombosis), hyalinisation of wall, karyorrhexis, etc. It is of course possible to find microscopic interstitial haemorrhages even where these may not be visible with the naked eye.

## LUNGS.

In many cases the lungs show little or no change. Cyanosis in a variety of shades and pattern is quite a common feature. In some cases oedema may be pronounced, to the point of showing wide infiltrated interlobular spaces, and profuse froth and serum oozing from cut surfaces. In other cases reddish irregular patches or spots (haemorrhages) appear singly or disseminated throughout the whole organ. In such cases also the consistence of the organ appears altered. There is consolidation, partial or complete, of some areas (broncho-pneumonia). Sometimes the darker areas seem partly atelectatic rather than simply inflammatory. Exudate in appearance varying from frothy blood to turbid, greyish slime can be expressed from the cut surfaces.

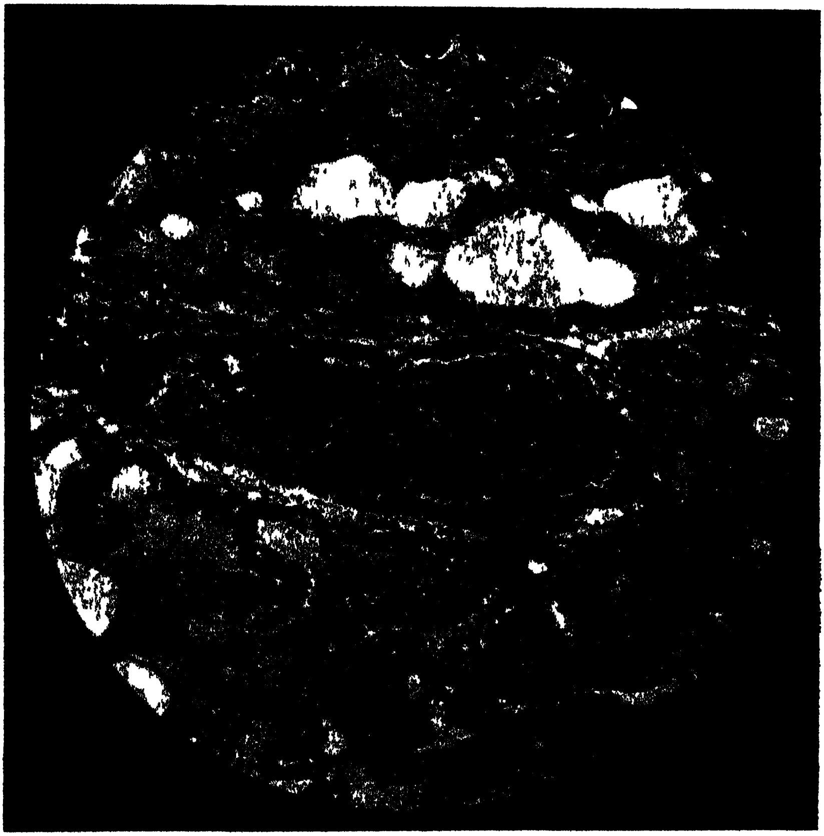

Fig. 3.—Lung. (Spec. No. P.S. 7556.) Thrombosis, oedema and hyperaemia. ×200.

Microscopically the picture includes any one or more of the following changes according to circumstance, hyperaemia, oedema (alveolar and interstitial), collapse of lung (partial atelectasis), broncho-pneumonia, pleuro-pneumonia, with varying amounts and nature of exudate (serous, catarrhal, haemorrhagic, fibrinous, necrotic) (see Fig. 3). Hyalinisation of the alveolar walls (capillaries) and blood vessels can be pronounced in outstanding cases, but is not easily recognised in the majority of cases. Hyalinisation and thrombosis of pulmonary veins is a relatively frequent occurrence, and necrotic effects especially diffuse karyorrhexis usually accompany them.

## SPLEEN.

The spleen may show little or no change visible to the naked eye, but usually it is swollen to a variable extent, occasionally reaching a size two or three times the normal. This swelling may be uniform and affect the whole organ, or it may involve one extremity only say ¼ or ½ of its length, or even be in the form of isolated, bulging, darker areas distributed at random in the pulpa. The swollen portions have a tense shiny capsule, thick rounded borders, and a greyish blue black colour as seen through the capsule. On section the colour is the deep purplish black of stagnant blood. The trabeculae are indistinct and seem to be stretched and overflowed by the pulpa. The lymphoid follicles are sparse, small and obscured by the bulging pulpa. The colour and consistence of this swelling indicate masses of coagulated blood in the pulpa rather than proliferative processes. In those cases in which swelling is not evident the pulpa appears normal in structure and of the usual brick red colour. In some, however, one may see small brighter red spots or zones scattered in the pulpa usually associated with the follicles.

Histologically the most striking and constant changes are briefly:—

(*a*) Hyalinisation and effacement of the Schweiger-Seidel sheaths or splenic ellipsoids.

(*b*) Congestion of pulpa, haemorrhage or infarction.

(*c*) Spreading apart and atrophy of lymphoid follicles.

(*d*) Pyknosis and karyorrhexis of reticulo-endothelial and lymphocytic cells.

(*e*) Endo-vascular changes—hyalinisation of wall, desquamation of endothelium, thrombosis and necrosis.

### (*a*) *Effacement of Schweiger-Seidel Sheaths.*

The Schweiger-Seidel sheaths or so-called splenic ellipsoids are bulb-like terminal enlargements of the final twigs of the pencil arteries. In the pig, as is well known, they are particularly prominent and distinct as roundish or oval structures composed of a mass of concentrically arranged endothelial cells. These bodies appear to form a delicate but loose meshwork through which the blood from the arterioles has finally to pass before it reaches the pulpa and sinuses. They are distributed throughout the spleen roughly in the proportion of 10 to 20 to each malpighian follicle around which they tend to form an irregular ring.

In all cases of Swine Fever it was noticed that the Schweiger-Seidel sheaths were affected to a greater or lesser extent. The majority show disintegration, smudging or total disappearance of the ellipsoid structure, so much so that no indication whatever may be left to mark their previous existence and situation.

Very often, however, shreds, or islands of hyaline substance with faint oval outline indicate where these structures existed. These islands which are usually loose-meshed, generally contain much blood, and sometimes there are indications of fibrin deposition and even of complete thrombosis. In a very few cases only do the ellipsoids remain fairly distinct in outline, although even here one may see very definite indicatons of necrobiosis of the delicate cells forming the spongy mass.

Probably these changes represent progressive steps in the destruction of the ellipsoids. At first the sheaths retain their form, only the delicate cells which make them up undergo pyknosis and beginning karyorrhexis. Then the cytoplasm becomes eosinophilic, hyalinised and fuses to a homogeneous mass or which is more usual, retains a certain sponginess with erythrocytes packing its meshes. In advanced stages in which haemorrhage is very extensive even this hyaline substance tends to disappear. It would seem as if the flood of blood here causes compression or disruption of these hyaline remnants or both, so that nothing is left eventually whereby these structures could be identified and their place is taken by the all pervading blood which congests the pulpa.

(b) *Congestion of the Spleen.*

The bluish black colour and swelling of the spleen mentioned earlier is seen histologically to be due to excessive accumulation of blood in the splenic pulp. Of course it is difficult to see whether this is to be considered as hyperaemia, haemorrhage or infarction on account of the complicated vascular system of the spleen. The fact that this accumulation of blood is often localised to more or less defined areas, the presence of fibrin in the ellipsoids and thrombosis of vessels are indications in favour of regarding it as of the nature of a haemorrhagic process.

(c) *Spreading apart and Atrophy of Lymphoid Follicles.*

In a spleen markedly swollen and congested as above the histological picture is quite characteristic. The pulpa cells are spread apart by the masses of blood between them and the same thing takes place as regards the malpighian follicles. Not only do the lymphoid centres appear fewer in a given field, i.e. further apart in the expanse of blood laden pulpa, but the follicles themselves are often much reduced in size and contain less lymphocytic cells, many of which may have undergone karyorrhexis. This process of disintegration seems to take place especially just around the central artery.

The shrinkage of the lymphoid follicle may also partly be due to atrophy resulting from the the pressure exerted by the accumulated blood as has been suggested by Seifried (1934). The latter goes so far as to link up the leucopaenia seen in swine fever with this phenomenon.

### (d) *Pyknosis and Karyorrhexis of Reticulo-endothelial and Lymphatic Cells.*

Karyorrhexis of endothelial cell nuclei in all tissues is characteristic of this disease. Pyknosis and to a lesser extent other regressive nuclear and cellular changes are also seen. This condensation and fragmentation of nuclear chromatin is generally extensive and affects endothelial as well as lymphocytic and allied cell types. It can be seen in the lining cells of blood and lymphatic vessels everywhere, but is particularly noticeable in the lymphatic glands and spleen where the reticulum and splenic cells appear very susceptible. *This change so conspicuously affecting endothelial and lymphocytic cells everywhere would seem to be the direct result of damage done by the virus* and can scarcely be attributed to, or confused with the more localised necrotic changes that arise secondarily as a result of thrombosis and infarction.

### (e) *Endo-vascular Changes.*

Apart from the alterations mentioned above in regard to the Schweiger-Seidel Sheaths the spleen on account of its peculiar anatomical blood vascular arrangement, does not present such marked intravascular lesions as other organs. Nevertheless it is possible to demonstrate hyalinisation, swelling and desquamation of endothelium and thrombosis in some of the splenic vessels.

## LYMPHATIC GLANDS.

The lymphatic tissues in general and certain groups of the lymphatic glands in particular afford perhaps the best and most constant single naked eye characteristic lesion in Swine Fever. The changes to be noted consist essentially in extravasation of blood into the reticular spaces and lymph sinuses. The glands so affected may show anything from a deep bluish black colour, through and through, to lighter diffuse or speckled red shading or to the normal appearance. Between these extremes all grades of intensity and distribution of the haemorrhagic effects may be seen (see Fig. 4). It is quite common to find glands showing a more or less well demarcated dark red peripheral zone or rind where the haemorrhage has taken place into the outer lymh sinuses mostly.

Outwardly the glands are swollen, and on section the cut surface may be moist or even watery, but in most cases presents a more or less firm and mat appearance indicating the presence of coagulated fibrin. Occasionally lymph glands may show a greyish mottled effect, an indication that thrombosis and subsequent necrosis are already far advanced.

Of all the lymphatic glands of the body the most constantly and prominently affected groups are the gastric and periportal. Next come the mesenteric, renal, sublumbar, thoracic, maxillary and then the other superficial groups. In the latter it is very unusual to find anything but a diffuse light reddening and swelling.

It is interesting to note that any of the groups mentioned may without any apparent reason show pronounced haemorrhagic changes over and above some or all of the others in a given case, and conversely in some cases the majority of glands may show damage to a similar extent.

Fig. 4.—Lymphatic glands. (Spec. No. 11700.) Extensive haemorrhagic appearance. ×¾.

Histologically the lymphatic glands also present a fairly typical picture which may be summarised in the following two sets of alterations:—

A.—Primary damage to the endothelial and lymphatic system as evidenced by the diffuse karyorrhexis of these cells, and B. secondary circulatory disturbances and their complications arising from A., e.g. blood extravasations, lymph stasis, thrombosis and necrosis.

A.—Extensive and diffuse karyorrhexis of the reticulo-endothelial nuclei in all the lymphatic tissue is *such a constant and characteristic feature of the histological picture that it deserves special attention.*

In the earlier stages of the disease or in organs so mildly affected that other histological changes are not yet apparent, karyorrhexis is usually already discernible here and there in a number of cells to an extent which at any rate enables one to suspect if not to diagnose the disease definitely . A study of stained smear preparations made from the pulp of glands or spleen gives one a very good insight into some of the nuclear changes which take place in the endothelial cells and lymphocytes. The nuclear chromatin of some of these cells seems to become flocculated into what appears to be a loose and bulkier, fluffy mass of chromatin within the nuclear membrane. Another and more striking phenomenon is seen in a great proportion of cells. It consists of " condensation " of the chromatin (pyknosis) into denser and darker shining masses which tend to divide rosette wise into smaller globular or tear-drop shaped fragments of chromatin (see Fig. 5). In many instances it appears as if the chromatin was being squeezed out not only from the nuclear membrane but from the cytoplasm as well, so as to be outside the cell entirely. Such spongy nucleus-less cell remnants are not infrequently encountered in smear preparations. In addition to the nuclear changes one frequently sees in gland smears, but also blood and other organ smears, globular fragments of cytoplasm floating in the plasma. These vary in size from 1 or 2 to 10 or 15 μ. They stain very faintly with Giemsa solution and often appear as mere bubbles,

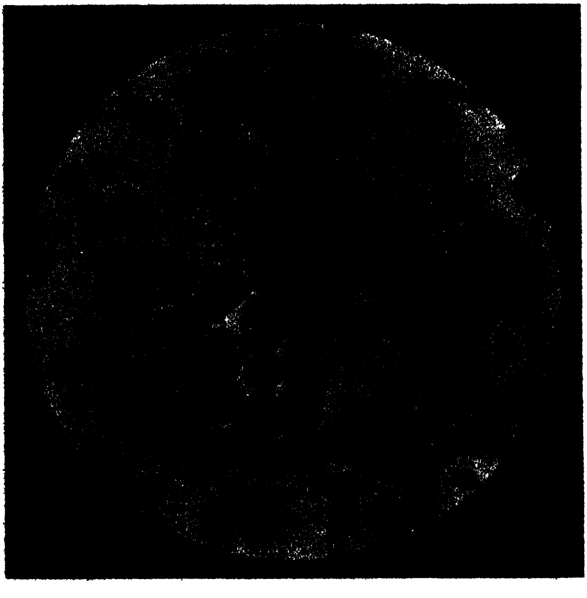

Fig. 5.—Specimen No. 1173. Smear periportal lymphatic gland. Group of karyorrhetic cells. ×700.

their colouration approximating that of the lymphocyte cytoplasm, i.e. very light grey blue. Actually the cytoplasm of a number of large lymphocytes show the bulging pseudopodia which might be taken as indications that these fragments are "pinched" off from parent cells. On the other hand these fragments which at times may be very numerous, are more likely to originate from endothelial cells which have broken up or desquamated at the time that they lost their nuclei as indicated above.

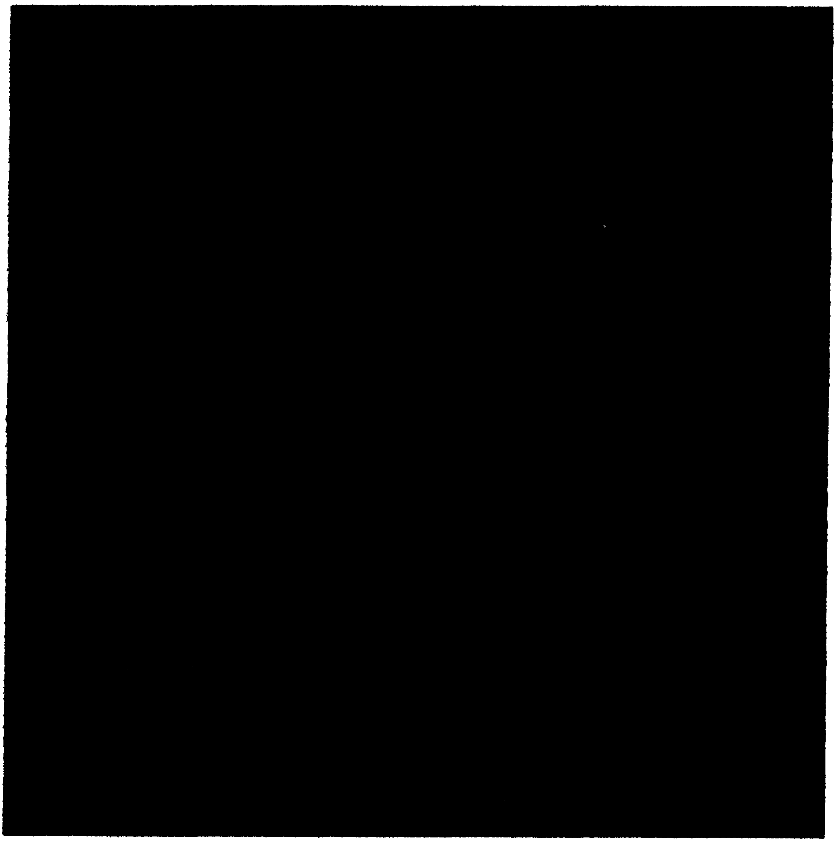

Fig. 6.—Spleen. (Spec. No. 14472.) Thrombosis and hyalinisation of S.S. sheaths, also karyorrhexis and lymphoid atrophy. ×135.

B.—Even in glands mildly affected there is always an engorgement of the capillaries and pre-capillaries in the reticular tissue. Normally these capillaries are scarcely distinguishable as endothelial tubes unless they contain blood since their wall consisting as it does of a single layer of endothelial blends with the rest of the reticulum. As the disease develops, this thin one-celled wall becomes thickened, swollen, blurred and macerated looking. This hyalinisation may present a perfectly homogeneous pink staining appearance (H.E.) sometimes having a finely lamellated, spongy or even vacuolated structure (see Figs. 7 and 8).

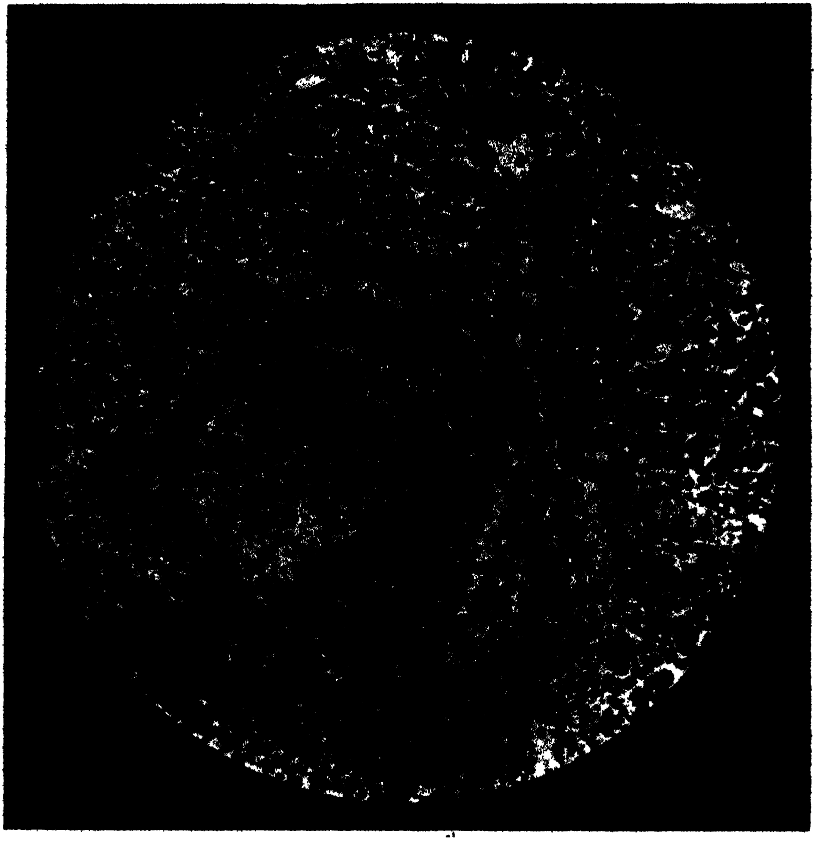

Fig. 7.—Specimen No. 15168. Hyalinisation of one vessel wall. Karyorrhexis. ×240.

In the earlier stages of the disease or in lightly affected glands the reddening may be due to hyperaemia only, and the vessel walls may scarcely show any recognisable changes. In the more advanced stages, however, such as is usually the case with the periportal or renal lymphatic glands, the deep reddening and swelling is due to extensive blood extravasation into the reticulum and even into the lymph sinuses. This extravasation may reach such proportions as to involve the whole gland in one large practically confluent haemorrhage or haematoma, in which the remnants of lymphoid follicles lie embedded, compressed, and isolated from one another. Not infrequently the haemorrhage into the peripheral and other lymph sinuses forms large pools of blood which overshadow the blood contents of the glandular tissue proper and give rise to the "black rind" or "nutmeg" aspect of these organs. Occasionally very little extravasated blood may be seen in the gland and yet the tissue may be extensively damaged showing necrosis, advanced karyorrhexis, hyalinisation of vessels and cellular disintegration.

The lymph spaces in such instances usually contain a network of fibrin and the blood vessels are more or less completely plugged by thrombi, thus probably interfering early with the blood supply.

The very extensive blood extravasation seems definitely to follow on the damaged state of the blood vessels especially capillaries and precapillaries. The red blood cells may frequently be seen caught in the meshes of a loose and spongy (hyalinised) vessel wall. In arterioles and precapillaries the inner lining of endothelial cells may be seen to swell up, disintegrate or desquamate in shreds, and even to become incorporated in the thrombi that may form here.

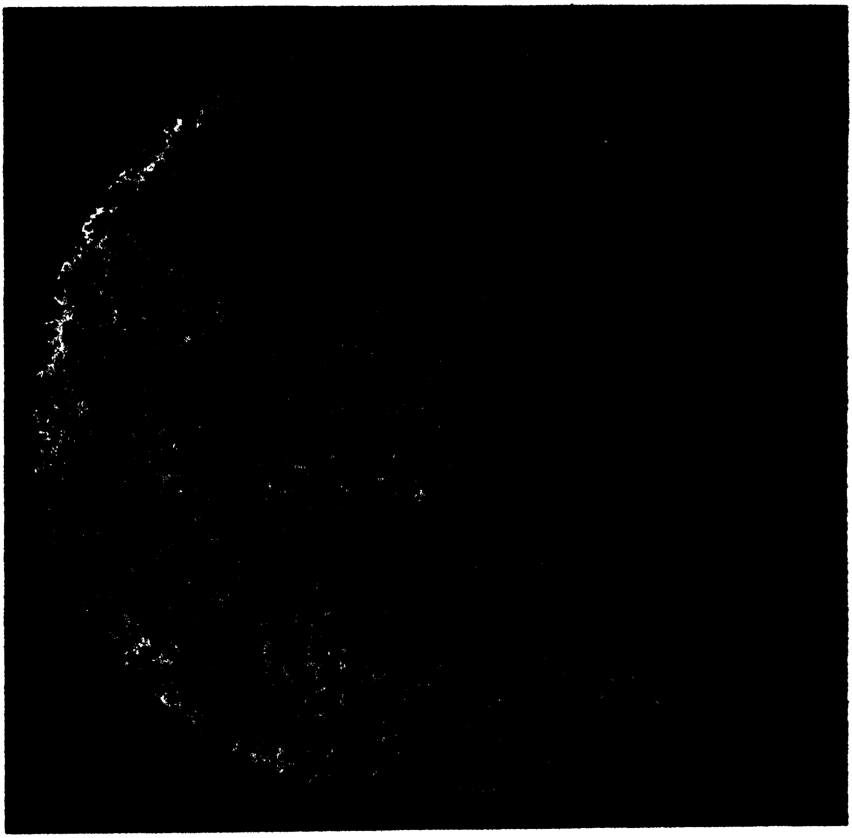

Fig. 8.—Specimen No. 15168. Hyalinisation of several vessel walls. Haemorrhages and karyorrhexis. ×200.

## STOMACH.

This organ shows hyperaemia with a fair degree of constancy. This occasionally may be severe even to the point of giving rise to haemorrhage. The stomach is usually full of food, the mucosa is covered with mucus and the fundus portion a light diffuse greyish pink to red, sometimes mottled and with erosions or ulcerations. In the worst cases brownish deposit or actual fibrin pseudomembrane or blood clots are present. In the milder cases, histologically one can see engorgement of the capillaries of the mucous membrane. In more advanced cases there is also fibrin present which then usually forms a clot occluding the vessels completely or in part. Vessels which undergo complete thrombosis rapidly lose their distinctive structure and become a blurred mass of protoplasm and fragmented chromatin. The mucosa over areas so affected becomes eroded at an early stage, with a variable loss of epithelium which leads more rarely to ulceration and bleeding. Infarction as a result of thrombosis of blood vessels is not infrequent.

### INTESTINE (SMALL).

The small intestine usually contains normal looking ingesta, and may not show any obvious abnormality. On the other hand a slight reddening of the mucosa with catarrh is a common occurrence and may be accompanied by subserous ecchymoses. Occasionally there may be a marked hyperaemia and a few cases presenting a severe haemorrhagic or even diphtheroid enteritis have been encountered.

### INTESTINE (LARGE).

The caecum, especially in the vicinity of the ileo-caecal valve frequently shows some degree of swelling and reddening. This region deserves special attention, since even the normal gut may have a misleading appearance. This small area close to the ileo-caecal valve of the caecum consists of lymphatic tissue mostly. It has a thicker, darker and wrinkled appearance and is grossly pitted by the numerous glandular crypts in this region which in turn are commonly filled with necrotic plugs and mucus which can be expressed out or scraped away without great difficulty. It is of course a well known fact that " boutons " in swine fever do occur in this region, but it is important not to confuse them with the dead detritus plugs of the normal crypts. The colon itself may show degrees of hyperaemia patchy or diffuse which in some cases become haemorrhagic. Extensive diffuse diphtheroid inflammation is noted occasionally. The lymphoid follicles may be prominent and sometimes show evidence of haemorrhages and necrosis, but it is noteworthy that typical " boutons " have not yet been seen in acute cases of swine fever in this country. In microscopic sections extensive haemorrhagic and also diphtheroid enteritis have been seen on rare occasions. At a rule, however, the vascular changes, haemorrhages and karyorrhexis are limited to lymphoid tissue, i.e. the solitary follicles of the colon and more particularly that of the ileo-caecal valve.

### LIVER.

The liver usually appears swollen and richer in blood than normal. When cut the surface thus exposed oozes out with a thick coat of blood. Irregular darker red patches or spots are sometimes seen through the capsule (haemorrhages). The lobulation remains distinct, but a speckled or nutmeg appearance may be seen due to lighter lobules or portions thereof and darker blood-filled ones.

Microscopically the marked congestion of the parenchyma is in the nature of a stasis which is not infrequently accompanied by atrophy of the liver cells. The liver sinuses are widened and blood-filled in parts to the point of forming small blood pools. The stasis usually extends over irregular portions of the liver lobules mostly towards its centre. The hepatic cells here may be atrophic or merely show compression, distortion due to blood accumulation or even necrosis with karyorrhectic nuclei of scattered cells.

The necrotic changes in the liver are fairly typical though inconstant and rather indistinct. Unlike those seen in paratyphoid the necrosis is quite diffuse, not sharply demarcated; in fact it seems at times as if single scattered cells are affected, while sometimes all the cells in part of the lobule seem to suffer. The stellate cells show karyorrhexis fairly constant, and the liver cells also tend to hyalinise and their nuclei to break up and disappear.

The gall bladder has been seen sometimes to show haemorrhagic and fibrinous inflammation. In such cases the wall is greatly swollen, red and oedematous and fibrin and blood clots are mixed with the bile.

## PANCREAS.

In a certtain proportion of cases this organ may show quite extensive and severe lesions while at times it remains practically unaffected. The following have been noticed:—interstitial and interlobular haemorrhages from small scattered ecchymoses to large extravasations reaching haematoma proportions. This organ frequently shows extensive and characteristic necrosis. This change is better seen when cutting through the gland, thus exposing the marmorated effect due to a combination of necrosis (greyish white, mat streaks and patches), haemorrhages (dark red patches) and fat saponification (yellowish white blotches) of the interlobular fat; the whole giving rise to a variegated mottling. In severe and advanced cases the whole pancreas may appear like a soft brownish mass, with deep greyish mottling interspersed with dark brown or black streaks of extravasated blood. These changes are very striking in histological sections where necrosis of the parenchyma in certain areas with attendant thrombosis and general karyorrhexis and disintegration of gland cells give rise to the greyish mat discolouration. The mottling is completed by the irregular haemorrhages and by the contrast between the normal fat and patches of saponified fat (fat necrosis) with their large fat cells filled with fan shaped fine acicular crystals of fatty acids or soaps. When the areas of necrosis are large the pancreas cells disintegrate rapidly and become a chromatinless mass of cell remnants, the typical karyorrhexis being seen only at edges near the healthy tissue.

## KIDNEYS.

The lesions in the kidneys are not constant. In a large proportion of cases there is nothing to be seen with the naked eye. For the rest haemorrhages in various grades of intensity and localisation may be seen. These vary from the smallest pinpoint red spots scattered in the cortical substance, to almost confluent red mottling of the outer and even inner zones. In extreme cases these may lead to large haematomata between the renal capsule and the kidney even extending into the renal fat. Pale or light patches and striations of the cortex may also be seen. The usual vascular changes in the kidney when present take the form of multiple pin point haemorrhages which arise apparently by extravasation from the smaller intertubular vessels (see Fig. 9).

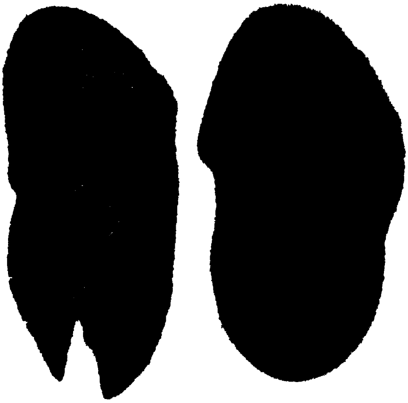

Fig. 9.—Kidney. (Spec. No. 6409.) Multiple haemorrhages. ×½.

Although the glomeruli are composed largely of endothelial cells there is remarkably little change (karyorrhexis, etc.) in this structure except in rare and very severe cases of lesion of the kidney, (see Fig. 10) where the hyalinisation and porosity of the blood vessel wall is clear and the consequent manner of extravasation obvious.

Degenerative processes of varying degree are also commonly seen. Albuminous hyaline substance in the tubular lumen is a common occurrence. This usually goes paired with a granular cytoplasmic disintegration which may even go over to hyaline droplet formation. Karyorrhexis of the tubular epithelium is rare and even the endothelium of the glomerulus shows this only in exceptional cases as mentioned above.

### ADRENALS.

The adrenals have been found on several occasions to show haemorrhages in the cortex and medulla. Other lesions of significance were not seen.

## UROGENITAL SYSTEM.

The urinary bladder, ureters, urethra, uterus and ovaries and testes of cases examined have not shown significant lesions beyond small occasional haemorrhages which could be correlated with similar occurrences elsewhere. No specific microscopic changes could be found either.

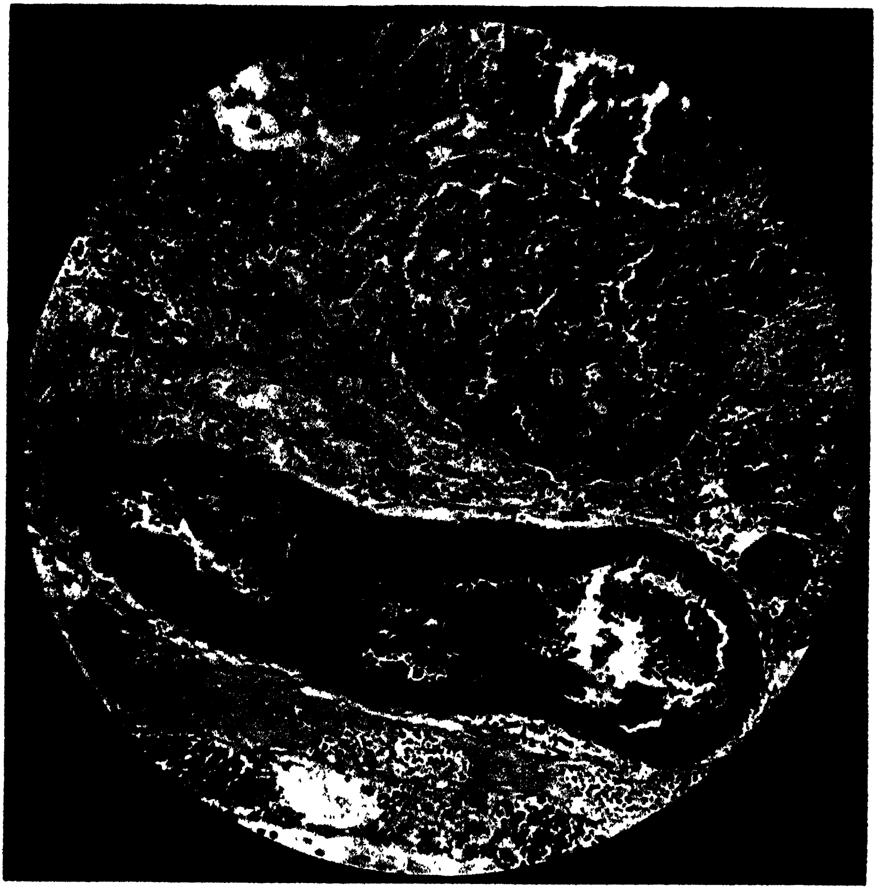

Fig. 10.—Kidney. (Spec. No. 15385.) Advanced hyalinisation and extravasation, glomeruli. ×200.

## BRAIN.

Congestion of the meninges is a fairly frequent occurrence and it is not always easy to assess its significance. Actual haemorrhages may also be present but are usually very small and not easily seen with the unaided eye. Microscopically small perivasculai haemorrhages are seen in some of the cases. They are usually localised immediately around and along the blood vessel or under the pia mater (see Fig. 11).

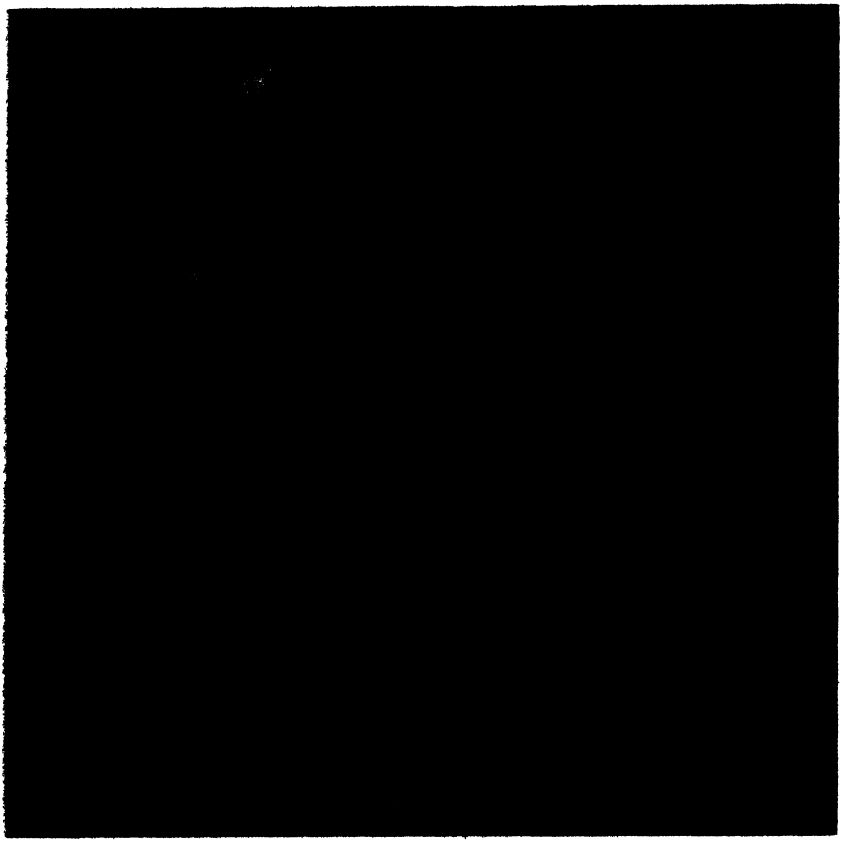

Fig. 11.—Brain. (Spec. No. 14818.) Extravasations from brain showing karyorrhexis. ×185.

Occasionally the extravasation may extend into the brain substance proper. The blood vessels and capillaries of the brain do show hyalinisation of their wall and karyorrhexis of their endothelial lining, but this is nowhere as distinct or constant as that seen in the lymphatic glands. The vessels frequently contain clots of hyaline or fibrinous nature (thrombi) which may fill the lumen totally or only in part. There is little doubt that the extravasation taking place originates from the blood vessels themselves since the blood very frequently forms a sort of mantle along the adventitia. Perivascular round cell infiltrations such as are described by most workers on swine fever are conspicuous by their absence. Of course, Seifried (1934) maintains that the occurrence of these infiltrations as a diagnostic lesion can be very misleading and it is even being suggested that they are the result of a totally different aetiological cause (virus) which often but not necessarily coincide or precedes Swine Fever.

## BLOOD.

Only a few and rather preliminary observations were made to date on the blood changes. These, however, will serve to show that there are important changes in the blood and that some of these agree to some extent with those recorded in swine fever in Europe.

The following figures were obtained in counts made before inoculating and during the course of the disease, on experimentally produced cases:—

TABLE I.

| Pig. No. | Date. | W.C. | R.C. Million. | Red. precip. | L. | N. | E. | M. | B. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1137 | 7/7/36 | 7,400 | 7·84 | 32 | 29 | 60 | 1 | 9 | 1 | Inoculated virus 7/7/36, |
| | 10/7/36 | 5,400 | 8·41 | 40 | 49 | 48 | 1 | 2 | 0 | died S.F. 11/7/36. |
| 1148 | 7/7/36 | 18,600 | 9·87 | 51 | 80 | 14 | 3 | 3 | 0 | Inoculated virus 7/7/36, |
| | 10/7/36 | 11,100 | 7·97 | 34 | 51 | 45 | 3 | 1 | 0 | killed *in extremis*, 11/7/36 |
| | 11/7/36 | 14,000 | 7·12 | 40 | 66 | 26 | 0 | 8 | 0 | |
| 1147 | 17/7/36 | 16,400 | 5·77 | 27 | 34 | 56 | 0 | 10 | 0 | Inoculated virus 17/7/36, died 19/7/36, before 2nd count. |
| 1154 | 17/7/36 | 8,800 | 7·91 | 37 | 68 | 27 | 1 | 4 | 0 | Inoculated virus 17/7/36, |
| | 20/7/36 | 10,300 | 5·52 | 28 | 60 | 34 | 3 | 2 | 1 | died S.F. 20/7/36. |
| 1165 | 25/7/36 | 27,100 | 8·89 | 37 | 32 | 64 | 0 | 4 | 0 | Inoculated virus 25/7/36, |
| | 27/7/36 | 7,300 | 5·49 | 27 | 54 | 39 | 1 | 6 | 1 | died S.F. 30/7/36. |
| 1185 | 25/7/36 | 20,200 | 8·03 | 37 | 42 | 53 | 0 | 5 | 0 | Inoculated virus 25/7/36, |
| | 27/7/36 | 11,400 | 7·74 | 34 | 43 | 55 | 0 | 2 | 0 | killed 31/6 36 *in extremis*. |

It will be noted that a decrease in the white count as well as in the red count is a frequent occurrence although by no means an absolute rule. The differential count as it stands does not present much of significance, the figures being too erratic and based on too few observations necessitated by the very short course of the disease before the fatal ending. Blood smears made from advanced cases show as a rule various degrees of poikilocytosis and anisocytosis. Often there is quite a fair percentage of normoblasts and Jolly bodies. Of some diagnostic significance is the karyorrhexis of the nuclei of the large lymphocytes and monocytes as seen in preparations made from the pulp of glands or spleen. The nature of this karyorrhexis and the resultant broken chromatin is fairly typical in that the chromatin appears to be squeezed out of the nuclear membrane in the form of "tear drop" or irregular blobs of various sizes and shapes. A number of these chromatin fragments are to be found lying free in the preparation separate from large lace-like or loose spongy masses which would appear to be the nuclear membrane and spongy tissue divested of its chromatin. Small rounded and very faintly staining bubbles or globules are also frequently encountered. They vary in size from about a fifth to double the size of an ordinary red blood cell. They are to be found lying free among the cells of a gland or spleen pulp preparation. Often they tend to adhere to other cells particularly monocytes and may also be phagocytozed by large macrophages. These bodies are regarded as fragments of cytoplasm probably arising from disrupted cells having lost their nuclei or by a process of pinching off a cytoplasmic pseudopodia such as are seen protruding from the cytoplasm of large lymphocytes or monocytes.

## PATHOLOGICAL CHANGES IN CHRONIC CASES.

The changes recorded below were observed in natural chronic cases in the Western Province outbreak in 1934. The sick pigs were usually one or more of the few remaining alive 14 days and up to a month after the onset of acute outbreak and mortality.

It is interesting to note that in many of the farms visited the only surviving animals were litters of very young suckling piglets farrowed at the time of the outbreak. These appeared not to have contracted the disease at all and grew up perfectly healthy.

The recovering or chronic cases were usually young pigs but occasionally mature pigs were also seen in the chronic stages. These animals were all emaciated and in a very miserable condition. The younger animals showed swellings—usually on the joints (carpal and tarsal)—but also along the tendon sheaths, stifle, phalangeal joints, under the maxilla and on the snout. These swellings were non-painful, soft and sometimes fluctuating slightly. On section they consisted of large accumulations of yellowish grey matter (fibrin) within a fibrous tissue walled cavity. The skin around was also oedematous.

Some of the swellings were due to enlarged lymphatic glands, e.g. sub-maxillary, which on section showed a greyish yellow firm necrotic appearance.

The heart and heart sac in many cases showed extensive pericarditis. The pericardial sac being distended with a milk or dirty greyish fluid in which numerous floccules and shreds of fibrin were present. The epicardium was usually thickened and covered with a greyish white, soft deposit of exudate of necrotic appearance.

The spleen often was normal in appearance but in some cases there were dark firm enlargements of somewhat nutmeg appearance. On section pericapsular fibrinous and fibrous adhesions were also seen.

The lymphatic glands varied a good deal in appearance. Some were swollen and necrotic, i.e. with greyish mat pulp, others were dark reddish grey and firm, while others still were swollen and red or mottled or even very little changed.

The lungs often showed varying degrees of catarrhal bronchopneumonia. Occasionally the lung was affected in patches but more often only in portions of the apical and cardiac lobes.

The intestinal tract was carefully examined for possible changes but in no single instance were lesions even suggesting boutons encountered.

The kidneys did not present much of significance but degenerative changes were to be seen.

Blindness in one or both eyes, accompanied by atrophy of the bulb and opacity of the cornea which developed during or after the disease was a feature seen in three pigs.

## INCIDENCE OF LESIONS.

The foregoing description of lesions represents a summary of the pathological changes seen in over 150 cases of Swine Fever, both natural and experimentally produced.

The histological examinations for the purpose of this study included material from some 197 pigs, 155 of which died or were killed while suffering from the disease. There were thus 42 animals dead from a variety of causes other than Swine fever for a comparison of the organ changes and determination of their relative value or specificity in diagnosis.

An analysis of the relative frequency of significant lesions in the chief organs as given below is of some interest as an indication of the organs best suited for histological diagnosis of this disease. In all cases included in this table, swine fever was diagnosed histologically in one or other organ.

TABLE II.

| Organ. | No. Examined. | Positive Lesions. | Negative. | Percentage Positive. |
|---|---|---|---|---|
| Lymphatic gland (periportal)............ | 131 | 127 | 4 | 97 |
| Spleen.................................. | 133 | 128 | 5 | 96 |
| Liver................................... | 106 | 86 | 20 | 81 |
| Lung.................................... | 61 | 39 | 22 | 64 |
| Kidney.................................. | 117 | 60 | 57 | 51 |
| Brain................................... | 76 | 37 | 39 | 48 |

The number of other organs examined was too small to permit of their inclusion on a comparative percentage basis. It will be seen, therefore, that positive histological diagnosis using one organ can only be established roughly to the extent of the order indicated in the percentage column.

In practice, however, and provided the spleen and lymphatic gland as well as some of the other organs are included the chances of arriving at a satisfactory diagnosis are even better than when relying on a single organ. These figures naturally refer to organs of animals dead from the disease or killed in a fairly advanced stage of its development. The number of positive cases established histologically would probably fall rapidly as soon as organs from animals in the earlier stages of the disease were examined.

## SIGNIFICANCE OF THE LESIONS OF SWINE FEVER IN SOUTH AFRICA.

It is fairly clear from the foregoing descriptions that the main pathological changes in this disease are the results direct or indirect of a marked interference with the vascular system.

Since a virus is accepted as the aetiological agent of this form of Swine Fever we have to assume that it falls in River's third group, namely one which causes a straightforward necrosis of the cells affected. There is also ample evidence of the cell specificity of the virus since the lesions at the onset of pathogenesis are practically confined to cells of the endothelial type, in other words, the lining cells of capillaries, precapillaries, veins, arteries, lymphatic vessels, reticulo-endothelial tissue, etc. In fact some of the more spectacular naked eye lesions like the haemorrhages, extravasations, thrombosis, infarction, etc., are probably secondary vascular accidents and complications arising out of the damaged vessels.

Once the full significance of the changes to the capillary wall is grasped (and lesions in a few advanced cases of this disease leave one in no doubt on this score) it is a fairly simple matter to understand or explain the apparent inconstancy of the vascular changes in various organs e.g. why haemorrhages occur sometimes in the kidney, at other times in the lymphatic glands, in the brain or any other organ, depending apparently only on the degree of damage done to the endothelium of that particular organ or tissue in that animal. In other words it is not the presence of haemorrhages in a particular organ that is diagnostic of the disease but rather the manner in which such haemorrhages arise i.e. hyalinisation of vascular walls.

When these *histological changes* enumerated by Thomas in *the South African cases of Swine Fever* are compared with those under European conditions, as described by Geiger (1937), the very close relationship becomes apparent Unfortunately Geiger did not have an opportunity of studying the changes brought about by the African virus and relied on the observations of Walker and Steyn who, however, did not undertake a very intensive histological examination.

In the acute form of the *European disease* Geiger records a marked septicaemia characterised macroscopically by haemorrhages in various organs, especially in the lymphatic glands, urinary system, gastro-intestinal canal, and in the skin. The European virus of Swine Fever in the first instance causes changes in the vascular endothelial cells of the intima and a necrobiosis or hyalinisation especially of the capillaries and precapillaries, etc., etc.

## EXPERIMENTAL OBSERVATIONS.

The work on the etiology of Swine Fever which has been done in South Africa since 1932 may be conveniently discussed under the following:—

(1) Virus studies.

(2) Complications with secondary bacterial infections.

(3) Bacterial diseases of pigs resembling Swine Fever.

(4) The relationship between the European and African viruses.

(5) Part played by carriers.

(6) Study of the disease in small animals.

(7) Immunisation against Swine Fever in South Africa.

### (1) VIRUS STUDIES.

In previous outbreaks of swine fever in South Africa, Steyn (1928) found that he was dealing with a virus which would pass a Seitz filter. Both Montgomery (1921) and Walker (1933) were able to show that the virus of East African Swine Fever was filterable.

All investigators who have worked on the subject have come to the conclusion that Swine Fever found in Africa is caused by a filterable virus. Geiger (1937) did a number of filtrations using both Berkefeld and Seitz filters and came to the conclusion that the virus from South Africa was filterable.

With material from the Western Province outbreak in 1933 and 1934 a series of pigs was inoculated and in every case death occurred within a week with a marked temperature reaction and typical post-mortem lesions. Owing to the fact that in a number of cases a *Pasteurella* organism was isolated from them and in the material obtained originally from the Western Province, *Salmonella cholera suis* was found, some element of doubt existed as to whether the disease was really Swine Fever.

In the filtration experiments (see Appendix 1) there seems to be no doubt that the recent outbreaks in the Witwatersrand and in the Western Province were due to the filterable virus of swine fever. In the experiments carried out at Onderstepoort it would appear that mild reactions may occur with some filtrates and that the virus may in some cases fail to pass a Seitz filter.

### *Survival of the Virus.*

Steyn (1932) quotes the experience of Montgomery in East Africa that the virus of that country was viable 536 days in oxalate-carbol-glycerine, that blood allowed to decompose for 16 days was still virulent and that styes left unoccupied for 5 days after a dead pig was removed, were not infective. Steyn found that blood allowed to decompose for 70 to 84 days became non-virulent. He was able to show that blood preserved in an ice-chest for a year was still virulent. He confirmed Montgomery's observation that styes remain infective for less than 5 days after removal of dead pigs. He quotes a case, however, where a farmer put pigs into styes, three weeks after removal of infected pigs, and the new pigs developed the disease.

In an experiment on 23rd June, 1934, two pigs, 1000 and 1003, were inoculated with 10 c.c. each of a mixture of pig bloods kept from Steyn's experiments in 1928. One of these pigs, 1003, reacted and died of acute swine fever in 8 days. The other pig reacted and died 18 days after inoculation. It apparently caught its infection from contact with the other pig as it reacted after its mate died. The blood in this case was about 6 years old but had been stored in a cold room in the dark.

### (2) Complications with Secondary Bacterial Infections.

From what has been described in the previous pages one must conclude that swine fever is caused by a filterable virus, but the question arises to what extent secondary bacterial infections occur in this disease under South African conditions.

In his experiments on swine fever in East Africa Montgomery (1921) mentions that in rare cases he obtained cultures of *P. suisepticus* from the blood of pigs which had died of the form of swine fever he described. Walker (1933) does not mention having isolated either *P. suisepticus* or *S. suipestifer* (*S. cholerae suis*) from his cases of swine fever in East Africa. Steyn (1928) obtained staphylococci and *E. coli* from some of his cases but no other pathogenic type. Geiger (1937) did not find *S. cholera suis* or *P. suisepticus* in his cases of swine fever of the African type.

In the early cases of the disease at Gouda in the Western Province in 1933, swine fever was not suspected at first and specimens of spleen were sent to Onderstepoort in 50 per cent. glycerine saline from which a salmonella organism identified as *S. cholera suis* was isolated, and a vaccine was made from it for use in combating the outbreak.

In the first pigs inoculated with material from the Gouda outbreak, pure cultures of a *pasteurella* organism were isolated from the blood, and occasionally in further sub-inoculated pigs. No lesions of a pneumonic type associated with pasteurella organisms were ever encountered in any of the pigs used in the experiments. The experimental work done on laboratory animals and pigs is given in Appendix II.

In the course of a large number of inoculations into pigs at Onderstepoort about 80 cases have ended fatally and cultures have been made from the heart blood in every case. It is only exceptionally that paratyphoid bacteria have been encountered and in a small percentage of cases bipolar bacteria of the *P. suisepticus* type have been obtained in cultures, especially in primary sub-inoculations from natural cases. One must conclude that if paratyphoid organisms play any rôle in the production of lesions in swine fever in South Africa it must be a very limited one. In one case at Onderstepoort a *S. enteritidis* type has been obtained from a pig which died in a nutrition experiment, but no lesions of the type usually associated with paratyphoid in pigs were seen.

### (3) Bacterial Diseases of Pigs Resembling Swine Fever..

#### *Paratyphoid.*

Outbreaks of a disease in pigs have been encountered in South Africa in recent years which resembled swine fever, especially macroscopically, but the cause was found to be *S. cholera suis*.

Martinaglia and Robinson (1932) described an outbreak of a disease in pigs in Johannesburg in which *S. cholera suis* was isolated and no association with the virus of swine fever could be demonstrated.

An outbreak of a disease in pigs was investigated in 1937 at a farm in Johannesburg where a big outbreak of swine fever had occurred in 1934. From some of the cases from which material was sent for investigation, paratyphoid was finally diagnosed, although at first swine fever was suspected. The results of the investigations are recorded in Appendix III.

Blood samples from some of the pigs were inoculated into susceptible pigs. One of these pigs developed a slight temperature reaction, so it was bled and its blood inoculated into two susceptible pigs. These did not develop any symptoms of illness.

In view of the fact that no definite diagnosis had been made, a second visit was paid to the farm two weeks later, by which time 109 pigs had died. The mortality was still occurring at random in the pens. The chief symptoms noticed were weakness of the hind limbs and listlessness.

At this second visit seven pigs were available for post-mortem examination. The result of this led to the conclusion that there appeared to be lesions of swine fever but of a slight and subdued type or masked by paratyphoid lesions. It appeared as if swine fever of a less virulent type than usual was being dealt with. The low mortality rate and the presence in some cases of " boutons " in the intestine brought the disease more in line with the European type of swine fever. The result of the histo-pathological examination of the organs from these cases, the results of the cultural examinations and the inoculations of blood of five pigs into susceptible pigs are given in Appendix VIII.

It will be seen that *S. cholerae suis* was obtained from five of the cases and that the blood inoculations were uniformly negative. A series of inoculations into susceptible pigs was carried out with cultures of the *S. cholera suis* strain obtained from the outbreak. Apart from intravenous inoculation which produced acute septicaemia, the other experiments gave negative results. Susceptible pigs injected intravenously with 24 hours broth cultures of the strain *S. cholerae suis* showed a marked febrile reaction commencing on the day of inoculation and continuing until the pigs died on the fourth day. They showed no other symptoms except *reddening of the skin and cyanosis.*

However in the histological examination in no single case were the lesions typical of swine fever seen, although the naked eye lesions, e.g., reddening of the skin, reddening of the lymphatic glands, etc., in some cases suggested it.

A further outbreak occurred on the same estate early in December, 1939. During the investigations carried out (see Appendix III) the post-mortems revealed haemorrhages in the skin, severe gastritis with diphtheritic membranes, enlargement of the spleen, haemorrhagic periportal lymphatic glands, etc. In some, slight haemorrhage was noted in the kidney. The officer carrying out the first investigations expressed the opinion that the disease was strongly suspicious of swine fever. Further post-mortems subsequently conducted at Onderstepoort again resulted in a tentative diagnosis of swine fever. Blood was inoculated into susceptible pigs, cultures made, and suitable material collected for a careful histological examination. On the 28th December Dr. Thomas of the Pathological Section, Onderstepoort, however reported that although the *macroscopical findings* (e.g., ecchymoses lungs and kidneys, cyanosis and haemorrhosis skin, etc.) in the first lot of pigs were suggestive of swine fever, the typical lesions of this disease could not be confirmed histologically and *a definite diagnosis of paratyphoid was made.*

Typical lesions of paratyphoid were encountered, characterised by scattered pin point necrotic foci in the liver. Isolated necrotic centres were also encountered in the spleen and lymphatic glands of some of the cases. The histological diagnosis was supported by the bacteriological examination of the blood which revealed a pure culture of *S. cholera suis*. Furthermore no reactions occurred in the susceptible pigs inoculated with the blood.

The contributory cause of this outbreak may have been the heavy rains, which greatly affected the hygienic states of the styes, there being a shortage of shavings and sawdust. There was undoubtedly also considerable overcrowding of the pigs. It would appear that the mortality occurred in those pigs which had been introduced during the previous three weeks

Hutyra and Marek (1926) discuss paratyphoid in pigs and maintain that the intestinal lesions are frequently indistinguishable from those of swine fever. In an editorial on swine fever and paratyphoid in pigs in the *Journal of Comparative Pathology* (1933) the question of the relationship of the two conditions is discussed at length. Waldmann (1932) as a result of his studies on swine fever comes to the conclusion, however, that diagnosis by animal inoculation does not yield positive results in more than 50 per cent. of cases. Two further articles on paratyphoid which raise many points of interest are those by Shanks and Lamont (1938) and a circular notice (1938) by the Research Department of the Bacon Development Board of Great Britain. In the former the disease investigated by them was commonest in pigs eight to fourteen weeks and took the form of necrotic enteritis with occasional symptoms of pneumonia. All attempts to show any association with the virus of swine fever failed. In the latter publication reference is made to the importance of *predisposing causes* in cases of necrotic enteritis caused by *S. cholerae suis*.

### *Conclusions.*

Although the lesions in these Savoy Estate outbreaks somewhat resembled swine fever, especially macroscopically, it would, however, appear that the disease was *paratyphoid* for the following reasons:—

(*a*) The blood of infected pigs injected into susceptible pigs failed to produce any reaction;

(*b*) paratyphoid organisms were isolated from most of the cases;

(*c*) the mortality ceased of its own accord after a small percentage of the pigs had died;

(*d*) the microscopical lesions encountered were those of paratyphoid, and not of swine fever;

(*e*) apparently the following predisposing causes played an important part in these outbreaks, viz., newly introduced pigs, excessive rains which markedly affected the hygienic state of styes, overcrowding, etc.

## (4) The Relationship between the European and African Swine Fever Viruses.

Walker (1933) mentions that Montgomery sent blood from cases of East African Swine Fever to England but Stockman was unable to record a single survival when pigs immune to European swine fever were inoculated with it. Even hyperimmnue pigs succumbed. Virus and antiserum were obtained by Montgomery from England but when he inoculated pigs immunized with the virus and antiserum with blood from cases of East African swine fever, they invariably succumbed. No success attended attempts to protect against the disease with antiserum obtained from Budapest (Hungary) or from America. Pigs inoculated with the appropriate dose of antiserum and exposed to the East African disease by contact developed the typical acute type of the infection. Owing to the limited success which has attended the immunization of pigs against East African swine fever, it has not been possible to reverse the experiment and test the immunity of pigs immune to the East African disease against the European or American types. It has been shown by Hupbauer (1934) that a plurality of viruses of European swine fever does not appear to exist. If it did the immunization of pigs against swine fever would naturally become much more complicated.

In order to see whether there was any antigenic relationship between the South African and European types of swine fever the following experiments were carried out. The virus used was blood of a pig which died of acute swine fever as a result of inoculation with blood of a pig in the Johannesburg outbreak referred to elsewhere . The virus will be referred to as 1006. The serum used was imported from the United States of America.

In the first series of experiments the virus was inoculated under the skin of one thigh and the serum under the skin of the other one. Later the method was changed, the virus and serum being incubated together for 3 hours at 37° C., left in the refrigerator overnight and then incubated again for one hour before inoculation. This latter method was suggested by Alexander (1935) as a result of his experience with horsesickness serum virus inoculation in white mice.

The results of these experiments are given in Appendix IV.

### *Conclusions.*

The experiments detailed in Appendix IV are still incomplete. Owing to the extreme infectivity of the disease it has not been possible to carry out many experiments at one time.

It would, however, appear that where a small dose of virus is incubated with antiserum, there is complete neutralization without any immunity developing subsequently. In the earlier experiments done without incubation of the serum-virus mixture, there were indications that the serum delayed the onset of symptoms. There is a definite indication that a relationship exists between the viruses of European and South African swine fever as judged by these experiments and that the two viruses have an antigenic factor in common.

## (5) The Part played by Carriers.

Walker (1933) was unable to demonstrate that the blood of recovered pigs harboured the virus. Steyn (1931) showed that a recovered pig harboured the virus in its blood two months after recovery. Unfortunately he did not continue the experiment beyond this point. Waldmann (1932) in referring to the persistence of the virus in animals that have recovered from an acute infection, with or without being subsequently unhealthy in appearance, stated that it is not denied that such animals may be carriers of the disease, but little is known as to the proportion of carriers and the form and the duration of the excretion of the virus.

A few experiments were undertaken recently at Onderstepoort with the blood of pigs which had survived attacks of swine fever on several farms in the Piquetberg district of the Western Province. Blood was obtained from eight pigs which were slaughtered during the eradication campaign in the Western Province.

The results of these experiments are given in Appendix V.

### *Conclusions.*

The blood of six out of ten pigs which had shown symptoms of illness during outbreaks of swine fever, proved infective for susceptible pigs. In some of the cases recovered pigs harboured the virus for ten months in the blood. Experiments were not carried out beyond this point.

### *Wild Pigs as Carriers of Swine Fever.*

Montgomery (1921) showed that the blood of warthogs and bush pigs in Kenya might contain the virus of East African swine fever, as demonstrated by inoculation of susceptible pigs. Walker (1933) found that warthogs experimentally infected with the virus did not develop symptoms but harboured the virus in their blood subsequently. Steyn (1931) found that blood of three apparently normal warthogs from the Northern Transvaal harboured the virus of swine fever. Both Montgomery and Walker failed to demonstrate that contact of susceptible pigs with warthogs whose blood harboured the virus of East African Swine Fever resulted in infection of the pigs. In the case of the warthog, the virus is not excreted in the faeces and urine. For this reason Walker has put forward the idea that the infection is transmitted from warthogs to pigs by an insect vector.

Geiger (1937) mentions that with the European type of virus he was able to infect a young wild boar experimentally and it died on the 12th day after inoculation. A full-grown wild boar showed no symptoms even after inoculation with big doses of a very virulent virus, but it excreted the virus. The American wild pig, the peccary, develops no symptoms but harbours the virus in the blood if inoculated with the European type.

With regard to the part played by wild pigs as carriers of the infection in South Africa, ten samples of blood from warthogs have been examined, with results as set out in Table III.

### TABLE III.

*Blood Samples of Warthogs injected into Domestic Pigs.*

| No. of Pig. | Origin of Blood. | Result. |
|---|---|---|
| 724 | Berg en Dal, Potgietersrust............ | Reaction with recovery. |
| 725 | Berg en Dal, Potgietersrust............ | Blood subsequently found infective. |
| 726 | Gruispan, Potgietersrust............... | Reaction with death. |
| 727 | Welgemoed, Potgietersrust............ | Reaction with death. |
| 738 | Oranjefontein, Koedoesrand, Potgietersrust.............................. | No reaction. |
| 737 | Umfolosi Game Reserve, Natal........ | No reaction. |
| 737 | Umfolosi Game Reserve, Natal........ | No reaction. |
| 1047 | Koedoesrand, Potgietersrust........... | Reaction with death. |
| 1058 | Koedoesrand, Potgietersrust........... | Reaction with death. |
| 1105 | Crown Lands, Louis Trichardt........ | No reaction. |
| 1106 | Gravelotte, Pietersburg................ | No reaction. |

From the above it will be seen that some of the blood samples from apparently healthy warthogs collected in the Potgietersrust district produced reactions to swine fever with death when injected into susceptible (domestic) pigs. The pathological-anatomical and histological diagnosis of some of these cases are briefly enumerated in Table IV.

## TABLE IV.

| No. of Pig Injected. | Date of Death P.M. No. Spec. No. | Pathological Anatomical Diagnosis. | Histological Diagnosis. |
|---|---|---|---|
| 726 | 24/6/31 P.M. 10391 Spec. No. 11790 | Hydropericard: Extensive haemorrhage of lymphatic glands especially periportal. Numerous subcapsular and intracortical haemorrhages kidney. Coagulated blood caecum and colon with numerous haemorrhages in mucosa. Haemorrhage perirectal tissue | Extreme extravasation of blood in sinuses of lymph gland—pigmentation. There is practically no hyalinisation of vessels or karyorrhexis.<br>*Spleen:* Marked haemorrhages in pulpa; Schweiger-Seidel Sheath disappeared.<br>*Follicles* only slightly atrophied. Relatively slight karyorrhexis.<br>*Kidney:* punctiform haemorrhage cortex; hyalinisation glomeruli, droplet degeneration.<br>*Liver:* hyperaemia and slight diffuse karyorrhexis. |
| 727 | 30/6/31 P.M. 10415 No specimens collected | Hydropericard: subepicardial haemorrhages. Marked oedema and hyperaemia lungs. Degeneration myocard. Tumor splenis. Extensive haemorrhage of lymphatic glands especially periportal. Subcapsular and intracortical haemorrhages kidney. Subpleural haemorrhages. Haemorrhages in stomach and small intestines. Croupous typhlitis and colitis. | |
| 1047 | 6/11/34 P.M. 13720 Spec. No. 15627 | Hyperaemia lungs and liver. Mottling of periportal lymphatic glands. Slight tumor splenis. Haemorrhages cortex kidney. Extravasation left endocard. Slight hyperaemia stomach. Extensive haemorrhage peritoneal cavity with blood in pelvic region. Haemorrhage in bladder. | *Spleen:* No trace of Schweiger-Seidel sheath; follicles are indistinct and some show karyorrhexis (early). There is no marked haemorrhagic effusion.<br>*Lymphatic gland:* Severe haemorrhage; Karyorrhexis slight; hyalinisation very slight; follicles indistinct.<br>*Kidney:* Slight hyalinisation and karyorrhexis of vessels.<br>*Brain:* Nothing unusual.<br>*Heart:* Myocard—nothing unusual.<br>*Liver:* Fairly extensive intralobular patches like blood lagoons from which liver cells have disintegrated; necrosis-karyorrhexis. |
| 1058 | 31/1/35 P.M. 13927 Spec. No. 16000 | Localised degenerative changes liver. Haemorrhagic infiltration gall bladder. Hyperaemia periportal lymphatic glands. Hyperaemia small intestine. Slight hyperaemia stomach and large intestines. Hydroperitoneum and hydrothorax | *Brain:* Nothing unusual.<br>*Kidney:* Small haemorrhages.<br>*Gland:* Extensive karyorrhexis and hyalinisation; follicles distinct.<br>*Spleen:* Schweiger-Seidel Sheath disappeared. Karyorrhexis extensive. |

From Table IV it would appear that the lesions seen, although perhaps less significant, are nevertheless characteristic in all respects of swine fever. One gets the impression that these cases ran a peracute course and that consequently the lesions did not develop to the usual extent, particularly in respect of hyalinisation, thrombosis and karyorrhexis of the endothelial lining of smaller blood vessels.

## (6) STUDY OF THE DISEASE IN SMALL ANIMALS.

As a result of the work of Theiler (1931) with the virus of yellow fever many attempts have been made to establish the filterable viruses associated with many diseases of man and domesticated animals in laboratory animals in order to facilitate research on these viruses. Great progress has been made in research on yellow fever as a result of the discovery that it could be transmitted to white mice by intracerebral inoculation. The discovery that foot and mouth disease could be transmitted to guinea pigs very greatly facilitated research on this disease. More recently Alexander (1933) and Nieschulz (1933) have shown that the virus of horsesickness can be transmitted to white mice and guinea pigs by intracerebral inoculation, the virus becoming neurotropic in mice.

No record could be found in the literature of any attempt to transmit the swine fever of Europe and America to laboratory animals by intracerebral inoculation. It has been attempted in recent years as a result of the success which has been achieved with some of the filterable viruses, but the results have been negative and subsequently not recorded.

Dr. Alexander of this Institute attempted to transmit swine fever to white mice by intracerebral inoculation using the technique which had been so successful in the case of horsesickness. Fresh defibrinated blood from a pig at the height of the swine fever reaction was used but no success attended the experiment. Subsequently the writer has made repeated attempts to transmit the disease to white mice and guinea pigs but without success. Owing to the fact that in the primary inoculations with yellow fever and horsesickness, only some of the inoculated mice developed the disease and sometimes with a long incubation period of up to 18 days, the animals in the experiments were kept for at least 20 days before being discharged. In all the inoculations into white mice, half grown animals were used as in them it is possible to push the needle directly through the skull into the brain instead of inoculating through the occipital foramen. In the case of the guinea pig, again half grown animals were used. For inoculation of guinea pigs intracerebrally a method employed by Mason at Onderstepoort in attempts to transmit blue tongue and heartwater to these animals was used.

The results of these experiments are given in Appendix VI.

## *Conclusions.*

These experiments are in the nature of a preliminary investigation and further attempts will be made to see whether the virus of swine fever can be acclimatized to laboratory animals. The indications at present are that the virus cannot easily be so adapted, the attempts to transmit the infection to laboratory animals having failed up to the present.

### (7) IMMUNIZATION AGAINST SWINE FEVER.

Walker (1933) and Geiger (1937) record attempts to immunize pigs against African swine fever. Neither had much success with attenuated virus or organ extracts treated with various chemicals. According to Geiger (1937) on account of the trouble in getting recovered pigs, the preparation of an immune serum presents great difficulty. The results of serum virus inoculations are only of limited value. An immunity of a durable nature type cannot be obtained. Walker (1933) as a result of an experiment which he carried out maintains that in contrast to swine fever, African virus shows a plurality of strains.

On account of the fact that the policy of the government in South Africa in the eradication of swine fever was the slaughter one, and the fact that the facilities were unsatisfactory, attempts at the development of a method of immunization were not actively pursued.

In view of the recent success attained by McBryde and Cole (1936) with the immunization of pigs against swine fever with virus attenuated by the addition of crystal violet, some experiments were carried out to study the effect of crystal violet on swine fever virus. The technique employed followed the lines of that recommended by Dorset and described by McBryde and Cole. 90 Parts of virulent defibrinated blood from pigs in the acute stage of the disease were mixed with 10 parts of a 1 per cent. aqueous phenol solution and then with 5 parts of an aqueous 1 per cent. solution of pure crystal violet. The mixture was incubated at 37·5° C. as recommended by Dorset but the time taken to render the virus attenuated had to be established. For this purpose the experiments as detailed in Appendix III were carried out (see Appendix VII).

#### *Conclusions.*

No success attended attempts at attenuating the virus of swine fever by the use of the crystal violet method ot Dorset.

## HISTORICAL.

The earliest report of the existence of swine fever in South Africa is by Hutcheon (1903) who recorded its occurrence at the Government farm, Groot Constantia, Cape Peninsula, and immediately afterwards in the Paarl district. On investigation it was found that this disease had been very widespread and a heavy mortality had occurred. It had not been reported to the veterinary department either, having been concealed or mistaken for a parasitic broncho-pneumonia which had previously caused heavy losses. Hutcheon was of opinion that the disease had probably been in existence for more than two years in the affected areas, particularly on the Cape Flats. He introduced stringent control measures which included slaughter and burial of infected pigs, disposal of healthy pigs to the butcher and no introduction of fresh pigs to the farm for six months. Destruction of manure and thorough disinfection of the premises were undertaken. Only two outbreaks are recorded in 1905, both in the Malmesbury district of the Western Province.

Robertson (1905) in commenting on these early outbreaks refers to the absence of restrictions on the importation of pigs, either from other South African colonies or from England. He considered the disease may have been introduced prior to 1900, but that it was confused with broncho-pneumonia, or that *occult cases or carriers* had been introduced and had been responsible for the outbreaks. He pointed out that an extended quarantine period would be necessary in order to eliminate these latter cases. In describing the symptoms he refers to staggering gait, weakness of the hindquarters, large blotches on the skin of the neck, at the back of the ears, on the thighs, etc. A cough might be observed. The course was two to three days or longer in some cases. He laid emphasis on the changes in the digestive organs whereas pneumonia occurred in a number of cases. He described ulcers, single or confluent, varying in shape, from a yellowish grey to a black colour and usually circular in form. In the absence of these lesions Robertson considered a diagnosis of swine fever doubtful without further evidence. He noted the haemorrhagic appearance of some of the lymphatic glands, particularly the inguinal and those at the base of the lung.

As early as 1903 Stockman refers to outbreaks of swine fever in the Transvaal and considered that it had not as yet gained a footing. Provisions were made in Government Notice No. 834 of 1903 to deal with the disease. An outbreak of what was undoubtedly swine fever was diagnosed in the Krugersdorp district of the Transvaal in 1903. The pigs had been bought on the Johannesburg market but their origin could not be traced further. The outbreak was stamped out successfully. Stockman mentioned the part played by chronic cases or those not showing symptoms in the spread of the disease.

Gray (1904) records further outbreaks in the Pretoria and Krugersdorp districts of the Transvaal. These were stamped out by the usual methods, but the fear was expressed that the disease had gained a footing.

Theiler (1905) was inclined to connect the outbreaks in the Transvaal with those in the Cape and therefore prohibited the introduction of swine from that Colony. The pathological anatomical diagnosis of swine fever appears to have been beyond doubt (the photographs of Theiler show typical " boutons ").

In the blood inoculation experiments carried out by Theiler in 1905 interesting lesions were manifested. Changes in the mucous membrane of the gastro-intestinal tract varied from deep congestion with areas of commencing necrosis to advanced areas of necrosis in the large intestine. In a number of cases no changes are recorded in the spleen, kidneys and liver, and in some diffuse reddening and haemorrhages under the skin are mentioned. In a number consolidated areas in the lung are referred to and in a few, small haemorhages in the kidneys are recorded. In some the lymphatic glands are said to be congested and swollen.

Theiler came to the conclusion that the disease investigated by him in the Transvaal resembled hog cholera of America and the swine fever of Europe. He was however never able to trace *B. suipestifer* and concluded that the presence of this bacillus was not necessary for the development of swine fever.

With reference to the socalled swine plague which he also investigated at that time, Theiler maintained that in South Africa under natural conditions the lesions of swine plague are found as a rule associated with true swine fever. There was only one spasmodic case of swine plague in which *B. suisepticus* was found and where swine fever had to be excluded.

Gray (1906) refers to further outbreaks in the Transvaal, some stated to be complicated with swine plague, and he was of the opinion that the number of outbreaks reported did not truly reflect the actual position as many outbreaks were probably not reported.

In the reports of the Principal Veterinary Officer of the Union of South Africa from 1910-1918 references are made to swine fever outbreaks. Three outbreaks were reported in 1910 and in 1912 twenty outbreaks in the Western Province were effectively dealt with. In 1917 ten outbreaks with a heavy mortality were reported from five districts of the Western Province. Further outbreaks occurred in these areas in 1918 and cases were reported in the Eastern Province at Somerset East and Longhope. These outbreaks were effectively dealt with. It must be emphasized that these outbreaks were diagnosed on clinical and post-mortem findings, and it was assumed that they were the European type of swine fever.

No further outbreaks were recorded until 1926, when an investigation was made into a very virulent disease of pigs occurring in the Potgietersrust district of the Northern Transvaal. The farmers in the locality were unable to keep pigs on account of this disease and the mortality in some instances was 100 per cent. Pigs running free on the farms were most affected and warthogs were reported to occur in large numbers on the infected farms. Steyn (1928) investigated this disease and came to the conclusion that it was the same as that described by Montgomery (1921) in East Africa and called " East African swine fever ". Steyn (1932) showed that the disease was caused by a virus which could pass a Seitz filter. After subinoculation of the virus the incubation period was thirty-six hours to four days. After the initial temperature the period up to the time of death was usually two to three days, but in one case it lasted as long as eleven days. The disease was therefore very acute and the temperature sometimes reached 108° F. The most important postmortem changes described by Steyn were a croupous pneumonia, haemorrhage foci in the lungs, haemorrhagic infiltration of all the lymphatic glands and the kidneys and a croupous typhlitis. In 1931, 1932 and 1933 several fairly large outbreaks occurred in both the Zoutpansberg and Pietersburg districts of the Northern Transvaal with heavy mortality. The infection could not be traced to direct contact with warthogs but it was strongly suspected that that was the source of infection. Blood from some warthogs harboured the virus whereas recovered pigs might harbour the virus for two months in their blood. Steyn suggested that farmers in warthog areas should not keep pigs on account of the danger to the pig industry in general.

## DISCUSSION.

According to the above historical review it would appear that swine fever of the European type and resembling hog cholera of America appeared in South Africa about 1900. According to Robertson the disease was probably introduced into South Africa by means of infected animal products, occult cases, or carriers. The symptoms described by Robertson in many respects resemble the acute cases of swine fever seen in the Western Province and Transvaal from 1933 onwards, namely staggering gait, weakness of the hindquarters, and large blotches on the skin of the neck. Robertson also refers to the haemorrhagic appearance of some of the lymphatic glands. Theiler connected the 1905 outbreaks in the Transvaal with those in the Cape and prohibited the introduction of pigs from the Cape Colony. In experiments carried out, Theiler came to the conclusion that the *disease in pigs produced by the inoculation of blood* resembled hog cholera in America and European swine fever. Amongst the post-mortem changes described, the presence of haemorrhages under the skin and in a restricted number of cases small haemorrhages in the kidneys are mentioned besides consolidated areas in the lung and swelling and congestion of the lymphatic glands. Theiler also referred to the presence of " boutons " in the large intestine and in his photographs these lesions are very well represented. The disease in each of the larger outbreaks from 1900 onwards died out or was eradicated by the methods and precautions undertaken.

From the records it would appear that the disease did not make its re-appearance in South Africa in an epizootic form for several years. After 1926 intermittent outbreaks of a very virulent and infectious disease occurred in the Northern Transvaal, i.e. some considerable distance inland. Some of these outbreaks were investigated by Steyn and others and they were of the opinion that the disease was identical with the African virus disease of pigs described by Montgomery in East Africa. On post mortem there were invariably present subendocardial haemorrhages in the left ventricle, marked tumor splenis, haemorrhages in the kidneys, haemorrhagic changes in most organs especially in the periportal lymphatic glands. From his description of the disease and from the description of the cases in the recent Witwatersrand-Western Province outbreaks it would appear that the disease investigated by Steyn and by the authors was one and the same.

The macroscopical and microscopical changes described in this paper resemble the acute cases described by Seifried, Geiger and others, in case of the European virus, namely, haemorrhages in various organs, especially in the lymphatic glands, urinary apparatus, stomach, intestinal tract and in the skin. Reference is made to the haemorrhagic and marble-like appearance of the lymphatic glands. Geiger states that in the first instance damage to the vascular walls takes place in the form of a degeneration of the vascular endothelial cells and necrosis, a hyalinisation of the capillaries and precapillaries.

The swine fever lesions observed in South Africa are in general perhaps more acute, especially in respect of capillary injury. The absence of cerebral peri-vascular cellular infiltrations in the South African specimens should be noted but it is interesting to state that Seigfried has already expressed doubt as to the specificity or significance of these cerebral lesions in true swine fever.

Geiger reports that the hyper-immune serum prepared from the European virus had no effect on the virus from South Africa and from various data collected by him these two diseases should be regarded as aetiologically different. Although the earlier experiments on cross immunity between the European and African viruses gave no indication of a relationship between the two, the recent experiments at Onderstepoort would seem to give an indication that the two diseases have an antigenic relationship.

It is therefore quite likely that probably more than one " strain " of swine fever virus exists and that the South African one is particularly virulent. Analogies of this are furnished in case of the other viruses, e.g. horsesickness, blue tongue, foot and mouth disease, etc. In case of the Tzaneen horsesickness strains obtained by passage through a number of generations it was found that the one group remained extremely virulent with a mortality of about 100 per cent. in susceptible horses, whereas in the other group attenuation took place and the mortality was reduced to about 15 per cent. In their respective passages the highly virulent Tzaneen strain continued to produce symptoms and pathological changes associated with the respiratory system, whereas the more attenuated strain invariably produced the cardiac form of horsesickness. Although there was a definite antigenic relationship between them (both derived from the same virus), the more attenuated strain only partially protected against the virulent type in a small percentage of animals. The study of the possible existence of " several strains " of swine fever virus is to be continued. Experiments have also been planned to study the effect of the passage of the European strain of virus in warthogs.

Swine fever in the Onderstepoort experiments has been of such a virulent nature that there has been little opportunity of studying the problem of immunity, especially in recovered animals. Although some limited success has attended attempts to immunise pigs, the immunity produced does not appear to be very strong. Unfortunately experiments of this nature have been hampered by the fact that up to the present it has not been possible to transmit the virus of swine fever to laboratory animals more suitable for immunity observations on a large scale.

In respect of the spread of the disease during the recent outbreaks, especially in the Western Province, it will be seen that it was comparable to that of the European disease as described by Geiger.

From the above remarks it would therefore appear that the disease described by Hutcheon and Robertson in 1903 and later by Theiler in 1905 was the same as the disease investigated by Steyn in 1928 and by the authors from 1933 onwards. Furthermore the disease investigated on several occasions in South Africa resembles *the acute form of European swine fever.*

The disease in South Africa is evidently of a particularly virulent character and usually manifests itself in the form of *an epizootic.* Judged by the absence of reports of mortality in pigs it would seem that the Union has for periods of several years been free of this disease, whereas in most European countries it has remained *enzootic.* Has this been due to the elimination of the virus carrier by the slaughter out policy adopted as soon as outbreaks were reported? Did environmental factors and the fact that few pigs in the larger part of the Union are scattered over wide areas contribute to this? After these long spells of freedom from the disease where did the recent outbreaks originate? Apparently the recent Western Province outbreaks stand in relation to the occurrence of the disease in the Witwatersrand area. How was the virus introduced into this latter area, seeing that it is situated fairly far inland and was probably not due to the introduction of infected animal products or ship's garbage, responsible for the 1927-1928 outbreaks in Australia according to Seddon and Blumen (1931)? Indications are that the disease during the recent Witwatersrand outbreak came from the Northern Transvaal in pigs moved to the Johannesburg market. It is doubtful whether this disease could have smouldered in domesticated pigs in Northern Transvaal without manifesting itself sooner or later. The disease is of such a virulent nature with high mortality that it could not have been suppressed for long intervals.

Is the virus in South Africa maintained in a limited number of wild pigs in certain areas of the Northern Transvaal? It is not yet known to what extent wild pigs are infected in this area and how infection is transmitted to domesticated pigs (whether by contact or insect transmission). Such transmission from the wild pig to the domesticated pig probably does not occur frequently and that may explain the peculiar intermittent incidence of this disease in South Africa. In the investigations carried out it was shown that the virus collected from clinically healthy warthogs could produce a form of disease indistinguishable from the one derived from domesticated pigs. A point to be investigated in the near future is to ascertain whether the European " strain " of virus in passage through the warthog becomes exalted. Has the warthog adapted itself to the virus and did the original swine fever virus of domestic pigs come from wild pigs? (*c.f.* trypanosomes in game).

Steyn refers to the fact that recovered domesticated pigs harbour the virus for a period of two months. Unfortunately he did not carry the investigations beyond this point. From the investigations with pigs which survived during the recent outbreaks in the Western Province it was found that the blood of some remained infected for susceptible pigs for a period of ten months. In some of the outbreaks a few pigs recovered from the acute disease but remained in poor condition and showed a scaly condition of the skin. In the Western Province swelling of the joints of the legs was noticed in some of the recovered cases. The virus of swine fever belongs to the class of very resistant viruses. From experiments carried out it was shown that it survived for a period of six years if kept in a refrigerator in the dark, but decomposition will render it non-infective in about 70 days.

A bacteriological examination was carried out in all cases investigated during the recent outbreaks, and complications with secondary bacterial infections such as *P. suisepticus* and *S. cholerae suis* occurred only in a limited number of cases. In two recent outbreaks of a disease in pigs with fairly high mortality the aetiological factor was suspected to be *S. cholerae suis*. In most of these cases the symptoms were acute and macroscopically some of the lesions resembled acute swine fever. The disease in both outbreaks died out without causing a high mortality and the blood of infected pigs did not produce swine fever. Waldmann, however, states that in herds infected with the acute or chronic form of the disease, diagnosis by animal inoculation did not yield positive results in more than 50 per cent. of the cases. It would appear that in South Africa as in Europe and elsewhere outbreaks of paratyphoid do occur and may sometimes assume a septicaemic form.

It will be interesting to ascertain how far *B. suipestifer* is mainly or entirely responsible for the structural alterations in the bowel, especially the diffuse diphtheritic inflammation and the formation of " boutons " in the caecum and colon. In the recent outbreaks of Swine Fever in South Africa such changes were significant for their absence and from the large number of investigations carried out in which blood cultures were undertaken it would appear that these organisms were rarely present. Probably the disease in South Africa is of such a virulent nature that secondary organisms are not afforded a chance of developing the lesions of diphtheresis, " boutons ", etc..

## CONCLUSIONS.

1. It is believed that various outbreaks of swine fever in South Africa have probably occurred since 1900. The disease in domestic pigs produced by the blood of warthogs resembled the European disease. Probably in swine fever, as in many virus diseases, more than one " strain " of virus exists.

2. Reference was made to the virulent nature of this disease in South Africa, and the fact that it does not progress as an enzootic as in European countries. A number of recovered animals harboured the virus for long periods.

3. It is quite likely that the virus in South Africa may also be maintained in a limited number of warthogs in certain areas of Northern Transvaal where domestic pigs occasionally become infected. That may explain the intermittent incidence of this disease in South Africa.

4. From the investigations carried out it would appear that the following may occur in South Africa:—

(*a*) Uncomplicated very acute form of swine fever without manifestations of "boutons", diphtheresis, hepatization of the lungs, etc.

(*b*) Swine fever possibly complicated by such secondary infections as *S. cholerae suis* and *B. suisepticus.*

(*c*) A septicaemic type of *S. cholerae suis* infection in an enzootic form and probably associated with such predisposing causes as bad hygiene, overcrowding, defective feeding, etc.

5. A description of the main pathological changes is given, and the value of the histological examination of organs for diagnostic purposes is discussed.

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## APPENDIX I.

*Filtration experiments* carried out to ascertain whether the outbreaks were due to the virus of swine fever or to a bacterial infection, and to study the filtration properties of the virus.

*Experiment* 1.—

Pig 952 was inoculated with 5 c.c. of filtrate of blood from a pig which had just died from swine fever. The blood was laked by the addition of distilled water and salt was added to make the concentration .85% A Seitz filter with one asbestos disc was used. The inoculated pig did not develop any symptoms and was found to be susceptible when subsequently inoculated with virulent unfiltered virus.

*Experiment* 2.—

Pig 955 was inoculated with 5 c.c. of filtrate of blood from a case, and made in the same way as in the previous experiment. No reaction occurred.

*Experiment* 3.—

Pig 957 was inoculated with 10 c.c. subcutaneously of a filtrate from virulent swine fever blood. Again no reaction occurred.

As the filtration experiments with the Seitz filter had not shown the virus to be filterable it was decided to try Berkefeld filters. Infective blood was prepared in the same way as for the Seitz filtration experiments and passed through a Berkefeld N filter under low pressure. Larger quantities of this filtrate were used than of the Seitz as it was thought that perhaps the quantities used had been too small. In Steyn's experiments (1928) 2.5 c.c. of a Seitz filtrate was fatal. The Berkefeld filtrate was sterile on the two occasions when it was made.

*Experiment* 4.—

Pig 934 received 50 c.c. of a Berkefeld filtrate subcutaneously. It showed a typical reaction and died of swine fever on the 6th day. Another pig 935 received 40 c.c. of another Berkefeld filtrate subcutaneously and died of acute swine fever on the 6th day. In both cases a few staphylococcus colonies were obtained from the heart blood.

With blood from cases of swine fever which died in the Johannesburg outbreak in 1934, further filtration experiments were carried out. The blood was prepared in the same way as described in the previous experiments.

*Experiment* 5.-

Two pigs 979 and 991 inoculated with a Berkefeld filtrate. Pig 979 was inoculated subcutaneously with 5 c.c. and pig 991 with 5 c.c. into the lung tissue. No reaction occurred for 14 days.

Pig 979 then recived 5 c.c. of the filtrate intravenously and died of swine fever on 6th day. Pig 991 received 20 c.c. subcutaneously and died on 5th day after a typical reaction. It is possible the reactions were due to the first inoculations but this seems unlikely and the route of infection in one case and the higher dose in the other were probably the real factors involved.

### *Conclusions.*

It was found that the virus of swine fever would not pass a Seitz filter. Filtration experiments carried out with a Berkefeld filter were however successful.

## APPENDIX II.

*Experiments on laboratory animals and pigs with bacteria isolated from swine fever cases.*

The blood of the pigs which died in the first transmission experiment was inoculated into two rabbits. Each rabbit received 1 c.c. intravenously and died in less than 24 hours. Smears from the blood and cultures from it showed organisms of the *P. suisepticus* type in both cases.

Two white mice inoculated subcutaneously each with 1 c.c. of a mixture of the pigs' blood died in about 48 hours. Smears from the blood and cultures showed organisms of the *P. suisepticus* type in both cases.

Two rabbits were inoculated subcutaneously each with 1 c.c. of the pigs' blood. One died on the sixth day after inoculation showing a purulent pleuritis and peritonitis. Lesions of a general septicaemia were present and an organism of the *P. suisepticus* type was isolated from the blood. The second rabbit died on the eleventh day after inoculation but no lesions of pasteurellosis could be demonstrated and cultures from the blood were negative.

Owing to the fact that in some experiments with Seitz filtrates of blood failure was experienced in setting up any disease, the possibility had to be considered that an acute bacterial disease was being dealt with. In the later experiments with the disease, the bacterial complications seemed to disappear, though occasionally coccus types were isolated from the blood of experimental cases.

As both the *salmonella* and *pasteurella* types isolated from these cases were available for experiments it was decided to see what symptoms they would produce in pigs when inoculated with them.

*Experiment* 1:

Pigs 955 and 957 each received 3 c.c. intravenously of a 24 hour broth culture of *P. suisepticus* isolated from the cases previously mentioned. The pigs were inoculated on 23rd November, 1933, and the same day a high febrile reaction was shown in both cases, which persisted until death occurred. One pig died on 26th November, 1933, and the other on 27th November, 1933. The pigs remained lying down from the day of inoculation and could not be made to rise. There was some reddening of the skin. At post-mortem there were lesions of an acute septicaemia, with hyperaemia and oedema of the lungs, tumor splenis, hyperaemia of liver and kidneys and a diffuse gastro-enteritis. The lesions were very similar to those seen in swine fever, but there was a very short incubation period.

*Experiment* 2:

Pig 956 was inoculated on 14th November, 1933, with 2 c.c. of a 24 hour broth culture of *P. suisepticus* subcutaneously. No reaction occurred and the pig was inoculated on 23rd November, 1937, with 5 c.c. of virulent swine fever blood. It died of the disease on the 6th day after inoculation.

*Experiment* 3:

Pig 952 was inoculated intravenously on 22 November, 1933, with 3 c.c. of a 24 hour broth culture of the strain of *S. cholerae suis* from the Western Province. A marked febrile reaction commenced the same day and continued until the pig died on the 4th day. It remained lying down and would not rise but showed no other symptoms except a slight reddening of the skin and cyanosis. At post-mortem there was slight hyperaemia of the lungs, marked hyperaemia of the liver and spleen.

Cultures were made from the blood and spleen in five cases post mortemed during the big outbreak of swine fever which occurred in Johannesburg in February, 1934. One of these pigs showed a few organisms of the *P. suisepticus* type in the blood, but the others were negative with the exception of one which showed a few chromogenic cocci in the blood.

In November, 1933, a pig owner in Johannesburg reported that his pigs, 35 in number, had all died of an acute disease and one was brought to Onderstepoort for post-mortem. It showed lesions typical of swine fever and a susceptible pig inoculated died on the 6th day with typical lesions. Cultures from the blood showed *P. suisepticus* in pure culture.

In November, 1934, one of us (A.D.T.) paid a visit to the Western Province during the outbreak in the Malmesbury district. Several farms were visited where the disease had occurred prior to the visit. On one farm (de Kock, Vogelgesang) three sick pigs in poor condition were seen. One was killed but at post-mortem the only lesion was a broncho-pneumonia. Two pigs which had died that morning were exhumed and post-mortemed. Both showed a broncho-pneumonia, one this lesion only, but the other pin point haemorrhages on the kidneys, slight lymphadenitis and a gastric catarrh. Typical swine fever cases had occurred on this farm. Cultures from the blood and spleen were made but only colonies of staphylococci grew in them.

On 15th November, 1934, a pig 1060 was inoculated with 5 c.c. blood from the case which was killed. The pig died on 28th day after having shown two distinct temperature curves. Blood was taken from the pig during the first reaction and inoculated into pig 1057 on 15/12/34. This pig died of acute swine fever on the ninth day.

At the second farm (Jordaan, Radyn) the owner had lost all his pigs except a sow and five piglets. The sow had been sick for 14 days but had shown signs of recovery in the previous two days. The animal was killed and at post-mortem a subacute pericarditis and broncho-pneumonia were found. No lesions of the alimentary tract were seen. Cultures were made from the organs in glycerine. A few colonies of staphylococci and *E. coli* were obtained. Blood from the pig was inoculated into a pig 1049 which died of acute swine fever on the sixth day.

At the third farm (Richter, Bontheuvel) a small pig, two months old, was seen showing swollen glands and joints. It was stated to be recovering and the owner had lost all but a few piglets from swine fever. The pig was killed and at post-mortem, showed pericarditis and swelling of the joints, which contained a thick turbid fluid. Cultures from the fluid in the joint cavity showed colonies of streptococci. On 15th November, 1924, a pig 1051 was inoculated with blood from this case. It died on 20th day after inoculation but at post-mortem the lesions were those of an acute enteritis with a heavy ascaris infection but no lesions of swine fever.

Serum of this pig was tested with strains of *S. suipestifer and S. enteritidis* (Dublin) but no reaction was obtained.

At the fourth farm (Kitshoff, Spes Bona) heavy losses had occurred. A small pig was seen showing swollen joints and apparently recovering. It was killed and at post-mortem showed swollen necrotic submaxillary glands, a slight pericarditis, and a large caseous necrotic abscess on one carpal joint. No sub-inoculations were done from this case. Cultures showed staphylococci and streptococci in the material from the joint. The serum of the pig gave negative reactions with salmonella *S. cholerae suis* and *S. enteritidis*.

At the last farm visited (Burger, Ideal Hill) there were only a few piglets left, some of which had swollen joints. Two of the pigs with swollen joints were killed and at post-mortem extensive serous arthritis was seen and swollen glands. No sub-inoculations were done from these pigs. Cultures from the material from the joints showed a few coliform colonies of the *E. coli* type. Streptococci were present as well.

In March, 1936, an outbreak of swine fever occurred in the Louis Trichardt district of the Northern Transvaal and sub-inoculations with the blood of cases produced the acute disease. In some of the sub-inoculated pigs, *P. suisepticus* infection was observed.

The presence of *P. suisepticus* was demonstrated in some cases of swine fever and other organisms such as staphylococci were found in others. The organisms did not appear to have any etiological significance.

## APPENDIX III.

### RECENT OUTBREAKS OF PARATYPHOID IN PIGS ON THE SAVOY ESTATE, JOHANNESBURG.

### *The 1937 Outbreak.*

(*a*) *Cases in January,* 1937.

An investigation *re* mortality in pigs was carried out in January, 1937, at the Savoy Estates. Two dead pigs and three *in extremis* were available for post-mortem. During the previous month 26 pigs had died out of about 2,500 in the styes. The mortality was not confined to any particular pen but was distributed throughout the various pens.

*Case* 1.

Black sow, 6 months old. There was reddening of the skin of the abdomen and between the legs.

*The liver* showed hyperaemia but the periportal glands were unchanged. Slight enlargement and hyperaemia was noted in the *spleen*. The mucous membrane of the stomach showed a diffuse hyperaemia.

*Diagnosis.*—A definite diagnosis could not be made at the time, but *S. cholera suis* was isolated from the spleen.

*Case* 2.

Black hog about 6-8 months old. Reddening present on skin of abdomen.

*Lungs.*—Marked hyperaemia. Several small areas of hepatization.

*Spleen.*—Marked hyperaemia.

*Liver.*—Marked hyperaemia. Periportal lymphatic glands mottled, reddish grey, but not intensely hyperaemic.

*Kidneys.*—Marked hyperaemia. Numerous small pin point haemorrhages in cortex.

*Stomach.*—Deep red colour, with ulceration and diphtheritic deposit.

A tentative diagnosis of swine fever was made, pending the result of cultures and inoculation of blood into susceptible pigs.

*Case* 3.

Black and white sow, about 6 months. The only lesions found were hyperaemia of the lungs with small areas of hepatization.

No diagnosis was made pending results of cultures and histological report.

*Case* 4.

Black and white sow, about 6 months old, very thin, and with swelling of the left carpal joint.

*Lungs.*—Atelectasis of portions of both lungs.

*Kidneys.*—Large yellow areas in the cortex giving a mottled appearance.

The only other lesion was an extensive fibrinous deposit on the serosa of the intestines, liver and spleen.

*Case* 5.

Black hog 6 to 8 months, in good condition. There was reddening of the skin of the whole body.

*Lungs.*—Mark hyperaemia.

*Liver.*—Marked hyperaemia. Marked mottling of the periportal glands, of a dark reddish grey type.

*Spleen.*—Greatly enlarged. Marked hyperaemia.

*Kidneys.*—Marked hyperaemia. Numerous pin point haemorrhages in the cortex.

*Stomach.*—Diffuse bluish red colour of the mucous membrane, with ulceration and diphtheritic deposit. A tentative diagnosis of swine fever was made.

Blood from pigs 2 and 5 were mixed and inoculated into susceptible pigs at Onderstepoort but no symptoms developed as a result of the inoculation. One pig showed a slight temperature reaction, so it was bled and two further pigs inoculated. These did not develop any symptoms.

(*b*) *Cases in February*, 1937.

*Case* 1.

Black hog. It showed a slight hydropericardium and hydrothorax, pulmonary oedema and atelectatic areas in the lung. All the lymphatic glands of the body showed a marked redness round the periphery. The *stomach* showed a tenacious diphtheritic pseudo-membrane on the folds with haemorrhages in between. The *skin* showed an intense cyanosis. This case was tentatively considered to be one of swine fever.

*Cases* 2 *and* 3.

Were too decomposed for a proper examination. Pig 3 showed an extensive fibrinous pleuro-pneumonia and pericarditis.

*Case* 4.

Showed fibrinous pericarditis and pleuropneumonia.

*Case* 5.

Blotchy cyanosis of the skin.

*Spleen.*—Slight hyperaemia.

*Liver.*—Extensive and disseminated miliary necrosis. (Typical paratyphoid lesions.)

*Case* 6.

Black hog (killed).

*Lung.*—Adherent to thoracic wall. Extensive commencing consolidation. Adhesive fibrinous pericarditis.

*Caecum.*—Ileo-caecal value and part of colon showed a yellow flaky pseudo-membrane raised above the surface. Around this there was a red margin with slight concentric ringing. There was a diphtheroid enteritis with characteristic " bouton " formation.

*Case* 7.

Black sow. Poor condtion. Swollen off knee with necrosis of the joint.

*Hydrothorax.*—The only lesions seen were in the lungs which showed large atelectatic areas. Bronchial lymphatic glands were swollen and mottled.

*Bacteriological work and sub-inoculations.*

Pure cultures of *S. cholerae suis* were obtained from the blood of pigs 1, 4, 5, 6 and 7. Blood from pig 1 was inoculated into two susceptible pigs at Onderstepoort, and a mixture of bloods of 4, 5, 6 and 7 into two others. No reactions were observed in these pigs subsequently. A tentative diagnosis of swine fever had been made as a result of post mortem examination of the seven pigs but it could not be confirmed biologically.

In order to see what the effect would be of inoculating or dosing pigs with the paratyphoid cultures obtained from the cases the following experiment was carried out. A pig (1195) was given 5 c.c. of a mixture of cultures of *S. cholera* intravenously, the dose corresponding to about half an agar slope or culture. The pig died in 36 hours from an acute septicaemia. Pig 1197 received 500 c.c. per os of the same culture emulsion. It did not show any symptoms subsequently. A further experiment was then carried out in which two pigs were starved overnight and each given 500 c.c. of a dense emulsion of several strains of *S. cholera suis* from the cases in the outbreak. Each pig was given a mixture of four carbonates (to counteract gastric acidity) one with the culture and one half an hour before the culture to neutralize the gastric juice. These pigs did not show any symptoms of illness subsequently. Attempts to produce typical paratyphoid cases in pigs experimentally with cultures from the outbreak, therefore, failed.

In summarising the 1937 outbreaks at the Savoy Estate, it may be stated that at post-mortem examination one found fairly marked peripheral haemorrhagic lymphadenitis, hydrothorax and hydropericardium; pulmonary oedema and bronchial pneumonia; diphtheroid an haemorrhagic gastritis and enteritis (boutons); cyanosis of skin, fat saponification and necrosis of the pancreas; disseminated necrosis of liver (paratyphoid). Very few pin point haemorrhages in the kidney.

*Microscopically* the examination of organs from these cases showed in the majority disseminated necrosis with endothelioid proliferation typical of paratyphoid in the liver. In addition there were lesions of catarrhal bronchopneumonia and oedema. Acute gastro-enteritis—some catarrhal and a few diphtheroid in type. The lymphatic glands showed a varying amount of blood extravasation in the sinuses, but only a very slight degree of vascular hyalinisation and karyorrhexis. In the spleen there were the usual disseminated necrotic foci but the Schweiger Seidel sheaths were mostly intact or only slight karyorrhexis was present. Other organs also showed slight karyorrhexis and scattered haemorrhages.

## *The* 1939 *Outbreaks.*

A further outbreak occurred on the same estate early in December, 1939. Throughout the year the average number of pigs running on the estate has been about 3,000 with an average daily mortality of three pigs. There was a sudden rise in the death rate from the 6th of December.

The following is the record of deaths reported:—

6th—6, 7th—8, 8th—4, 9th—3, 10th—5, 11th—7, 12th—16, 13th—15, 14th—7, 15th—12, 16th—1, 17th—7, 18th—8, 19th—8, 20th—2, 21st—1, 22nd—2.

A number of small pigs of the pork type had been purchased for the Christmas period. There was also a number of poor quality pigs which did not seem to be thriving.

Post-mortems on 16 pigs on the 13th practically in all cases revealed the following: haemorrhages of the skin, severe gastritis with diphtheric membranes, enlargement of the spleen, haemorrhagic periportal, mesenteric, and gastric lymphatic glands, slight haemorrhages noted on the kidneys. These were regarded strongly suspicious of swine fever.

A number of carcasses were brought to Onderstepoort for post-mortem, histological and bacteriological examinations. Blood from some of these pigs inoculated into susceptible ones gave no reactions. *S. cholerae suis* in pure culture was obtained from the blood. As regards the pathology Dr. Thomas reported as follows:—

*Pig No.* 1 (Specimen No. 24184):

Cyanosis of the skin; phlegmosis of the sheath, general haemorrhagic appearance of the lymphatic glands, localised acute pneumonia, ulcerative gastritis, extensive catarrhal haemorrhagic enteritis.

*Gland* (pptl).—Marked extravasation in cortical sinuses with fibrin in parts and very little karyorrhexis and no hyalinisation of arterioles.

*Spleen.*—Rich in blood, s.s.s. are well preserved, practically no karyorrhexis, lymphoid centres not affected markedly, a few isolated necrobiotic centres.

*Pig No.* 2 (Specimen No. 24185):

Cyanosis of the skin with extensive multiple localised ulcers and haemorrhages in various stages, slight tumour splenis, diphtheroid gastritis with slight catarrhal enteritis, haemorrhages lymphatic glands, slight acute pneumonia.

*Gland.*—Same as above, small centres of fibrinous exudate, but less extravasations.

*Spleen.*—As above, less marked.

*Skin.*—Multiple crush covered-necrotic defects scattered over skin, some with a dark red edge, to blood filled cutis around, bacteria in necrotic bed.

*Pig No.* 3 (Specimen No. 24186):

*Gland.*—Irregular necrotic areas with thrombosed vessel, fibrin, haemorrhages in sinuses, slight karyorrhexis, but lymph follicles unaffected.

*Spleen.*—Pulpa rich in blood, s.s.s. still visible though much distorted, many necrotic areas isolated karyorrhexis not marked.

No liver was collected.

*Diagnosis.*—Paratyphoid.

*Pig No.* 4 (Spec. No. 24191) killed *in extremis*:

Haemorrhages lymphatic glands, ecchymoses kidneys, slight acute catarrhal gastro-enteritis, extensive acute pneumonia.

*Lung.*—Hyperaemia and irregular patches of consolid. with fibrin, serum and red cells.

*Gland.*—Slight peripheral extravasation.

*Liver.*—Scattered pin point lesions, some filled with red cells, others just an accumulation of endothelial cells.

*Spleen.*—Practically normal appearance.

*Pig No.* 6 (Spec. No. 24193) killed *in extremis*:

Ecchymoses lung and kidneys, fatty degeneration liver, few haemorrhages and cyanosis skin, slight acute gastro-enteritis.

*Gland.*—Hyperaemia and few necrotic centres.

*Spleen.*—Small indistinct necrotic foci. s.s.s. still present.

*Liver.*—As above but more extensive.

*Pig No.* 5 (Spec. No. 24192) killed *in extremis*·

Intensive patchy cyanosis of the skin, intense acute pneumonia and haemorrhages bronchial lymph glands, slight acute gastro-enteritis.

*Kidney.*—Hyalinisation of some glomeruli with consequent local haemotaria and degeneration of some tubules.

*Spleen.*—No great change.

*Liver.*—Disseminated endothelial, prolif, in irregular foci.

A definite diagnosis of *paratyphoid* was made histologically, supported by bacteriological examination and the fact that the blood inoculation into susceptible pigs was negative.

## APPENDIX IV.

Experiments on *the relationship of the European and African viruses of swine fever.* In most of these experiments the virus used, 1006, was obtained from the Witwatersrand outbreaks.

***Experiment*** **1:**

12th June, 1934. Two pigs were inoculated with 2 c.c. of virus 1006 subcutaneously, one pig receiving 50 c.c. of Swine Fever Antiserum (Lederle) in the opposite hind leg. The pig that received virus alone died on 4th day from acute swine fever and the pig that received serum died on 6th day after inoculation.

***Experiment*** **2:**

11th June, 1934. Two pigs were put in an infected stable. One pig received 50 c.c. Swine Fever Antiserum (Lederle) subcutaneously. This pig died of acute swine fever on 15th day, the control animal dying on 11th day.

***Experiment*** **3:**

25th June, 1934. Two pigs were again placed in an infected stable, one pig receiving 30 c.c. antiserum (Lederle) subcutaneously. Both pigs survived, apparently owing to the infection in the stable having died out.

***Experiment*** **4:**

17th August, 1934. Two pigs were inoculated subcutaneously each with ·2 c.c. of a virus obtained from another outbreak in the Northern Transvaal. One pig received 30 c.c. antiserum (Lederle) subcutaneously. Both pigs died of acute swine fever on 6th day.

*Experiment* 5:

17th August, 1934. Two pigs were inoculated subcutaneously each with ·2 c.c. of a virus from Gouda in the Western Province. One pig received 30 c.c. antiserum (Lederle) subcutaneously. Both pigs died of acute swine fever on 7th day.

*Experiment* 6:

26th July, 1934. Two pigs were inoculated with virus 1006 (Johannesburg) each receiving ·2 c.c. subcutaneously. One pig received 30 c.c. antiserum (Lederle) subcutaneously. The latter pig survived but when reinoculated on 16th August, 1934, with ·2 c.c. of the same virus it died of acute swine fever. The control pig died on 7th day.

As this survival of the initial inoculation with virus was of great interest, the experiment was repeated (Experiment 7) but this time both pigs died.

*Experiment* 7:

16th August, 1934. Two pigs were inoculated with virus 1006 (Johannesburg) each receiving ·2 c.c. subcutaneously. One pig was given 30 c.c. antiserum (Lederle) subcutaneously. The latter died on 6th day from acute swine fever and the control pig on 5th day.

At this point it was realized that perhaps the dose of virus was too big, so an attempt was made to roughly determine the minimum lethal dose of virus 1006. It was found that ·01 c.c. would kill in 7 days so this dose was used as probably representing several lethal doses.

It was decided to change over to the method of incubation of the serum virus mixture as previously mentioned and in all the subsequent experiments this method was used.

*Experiment* 8:

1st September, 1934. One pig was inoculated with ·2 c.c. virus (1006) and another with an incubated mixture of ·2 c.c. virus 1006 and 30 c.c. antiserum (Lederle). The virus pig died on 5th day but the serum virus pig survived to the 13th day. In all the experiments where incubated serum virus mixture was used the pigs were kept in separate boxes for fear that contact with the reacting virus pig would increase the exposure of the serum-virus pig.

*Experiment* 9:

25th September, 1940. Two pigs were inoculated subcutaneously each with ·01 c.c. of virus 1006. One pig received 30 c.c. antiserum (Lederle) which had been incubated with the virus. The pig which received virus alone died on 7th day from acute swine fever. The serum virus pig survived until 19th October, 1934, when it developed swine fever and died on 24th October, 1934.

There are two possible explanations of this late reaction, one being that accidental infection occurred, but in view of experiments on the recovered pig as a carrier it is possible that the virus was not completely neutralized by the serum.

*Experiment* 10:

11th October, 1934. This experiment was carried out to see whether normal pig serum would have any neutralizing effect on the virus. A pig was given ·01 c.c. virus which had been incubated with 30 c.c. normal pig serum under the same conditions as used for antiserum and virus. The pig died on 5th day from acute swine fever, so one may conclude that normal pig serum was without effect on the virus.

*Experiment* 11:

24th November, 1934. This was a repetition of experiment 9. The pig received ·01 c.c. virus 1006 alone, and died on 5th day. The pig which received serum survived. The survivor was not tested for immunity in this case.

In order to see whether serum obtained from other sources would give results similar to those obtained with the American antiserum (Lederle), some was obtained from Germany (Bayer) and from Hungary.

*Experiment* 12:

20th March, 1935. One pig was inoculated subcutaneously with 50 c.c. Bayer antiserum with ·01 c.c. virus (1006), and another with 50 c.c. of the Hungarian antiserum and ·01 c.c. of the same virus. A third pig received ·01 c.c. virus alone. This pig died on the 6th day from acute swine fever. The two pigs which received serum both survived. They were kept for 6 weeks and then inoculated with ·01 c.c. virus (1006) to see whether they had acquired any immunity. Both pigs died of acute swine fever on 6th day after inoculation so that apparently no immunity had been acquired.

*Experiment* 13:

7th November, 1935. This was a repetition of experiment 12. Two pigs received ·01 c.c. virus (1006) with 50 c.c. Bayer antiserum. A control pig was given ·01 c.c. virus (1006) alone. This pig died of acute swine fever on the 8th day. The two serum pigs survived. It was proposed to carry out further virus tests with these two pigs to see if a basic immunity can be developed on which immunization experiments could be carried out.

These two pigs were not found to have developed any immunity when tested with virus later, and both died of the acute disease.

### *Conclusions.*

The experiments show that there is some evidence of a common antigenic factor between the African and European viruses of swine fever.

## APPENDIX V.

Experimental work carried out with the blood of pigs suspected of being *carriers of swine fever virus.* Blood was obtained from a number of pigs in the recent Western Province outbreak.

*Pig* 1.

The outbreak occurred during November, 1934. The pig was ill for three weeks and showed reddening of the skin and swelling of the joints.

At post-mortem in April, 1935, small abscesses were seen in the lungs, pericardial adhesions, slight enlargement of the spleen, hyperaemia of the mesenteric glands. There were definite traces of the previous acute condition.

Two pigs 1070 and no number (S. 5679) were inoculated on 3rd May, 1935, each with 5 c.c. of blood. One pig reacted from 12th day and died on 20th from acute swine fever; the other reacted from 24th day and died on 28th. It is possible that the second pig became infected from the first as they were in contact.

*Pig* 2.

The outbreak occurred in September, 1934. The pig was ill for four weeks. At the time of the post mortem in April, 1935, the pig showed no symptoms. At post-mortem there were haemorrhages in the kidneys, and an adhesive pericarditis but no other lesions.

Two pigs 1068 and 1071 (S. 5670) were inoculated on 3rd May, 1935, each with 5 c.c. of citrated blood. No symptoms developed in the following two months. The blood of pig 2 was therefore not infective.

*Pig* 3.

The outbreak occurred in September, 1934. There was no information available as to whether the pig showed any symptoms at the time.

At the post-mortem in April, 1935, the following lesions were found. An adhesive pericarditis, an abscess in the myocardium, slight hyperaemia of the intestines, marked tumor splenis, marbled appearance of the periportal lymphatic glands and some haemorrhages in the kidneys. There was definite evidence of a previous infection.

Two pigs 1091 and 1094 (S. 5675) were inoculated each with 4 c.c. blood on 17th May, 1935. One pig reacted on 16th day and died on 20th from acute swine fever. The second pig reacted from 20th day and died on 26th. This pig was in contact with the other and may have become infected from it.

*Pig* 4.

The outbreak occurred in September, 1934. The pig was ill for four weeks and showed swelling of the joints.

At the post-mortem in April, 1935, it was in poor condition and showed pericarditis, mottling of the mesenteric glands, and slight splenic enlargement.

Two pigs 1092 and 1093 (S. 5675) were inoculated on 17th May, 1935. One pig reacted from the 25th day with death on 31st and the other from 24th with death on 30th. The inoculation period in these two cases was exceptionally long.

*Pig* 5.

The outbreak occurred in June, 1934. The pig was ill for seven weeks at the time of the outbreak.

At the time of the post-mortem in April, 1935, it was in good condition. The following lesions were seen at post-mortem: Old standing pericarditis, slight swelling of the joints, areas of broncho-pneumonia, mottling of the periportal glands, petechiae of kidneys.

One pig (S. 5679) was inoculated with 5 c.c. of citrated blood on 25th May, 1935. It reacted on 12th day and died on 16th from acute swine fever

*Pig* 6.

The outbreak occurred in June, 1934. There was no information available as to symptoms shown at the time of the outbreak.
At the time of the post-mortem there was evidence of swollen joints. At post-mortem the periportal glands showed a mottled appearance and old haemorrhages were seen in the kidneys.

A pig (S. 5679) was inoculated on 25th May, 1935, with 5 c.c. citrated blood. It reacted from 8th day and died on 12th with symptoms of acute swine fever.

*Pig* 7.

The outbreak occurred in December, 1934. The pig was ill for three weeks at the time of the outbreak.

At post-mortem in April, 1935, old pleural adhesions were found and haemorrhages in the kidneys, slight mottling and hyperaemia of the mesenteric glands.

Two pigs 1095 and 1096 (S. 5684) were inoculated, each with 5 c.c. citrated blood on 5th June, 1935. One pig reacted from 5th day with death on 15th from acute swine fever. The second pig reacted from 11th day with death on 16th. It may have become infected from the other pig, with which it was in contact.

*Pig* 8.

The outbreak occurred in September, 1934. At the time of the outbreak, the pig was sick for two weeks, showing staggering gait, swollen joints, swelling of the ears and eyes and blood oozed from the tips of the ears. At post-mortem on 26th June, 1935, the pig was in excellent condition. The spleen showed hyperaemia and the mesenteric and periportal glands showed enlargement and mottling.

Two pigs (S. 5699) were inoculated on 26th June, 1935, each with 5 c.c. of blood. Neither of these pigs showed any symptoms subsequently.

In addition to the eight pigs just referred to, blood was sent from two pigs killed at the Wellington Bacon Factory in January, 1935. Both these pigs had shown symptoms during an outbreak of Swine Fever in the Malmesburg District of the Western Province, nine months previously. Both cases showed evidence of previous swelling of the joints. There was slight enlargement of the spleen, but the main lesions were those of a bronchopneumonia and pleural adhesions. On inoculation of blood from these two pigs into susceptible pigs, no symptoms developed.

Two pigs 1104 and 1180 survived in experiments carried out at Onderstepoort. Both were subsequently reinoculated with viruses of different origin and survived.

Pig 1104 was inoculated again two months afterwards but did not show a reaction. It was kept for transmission experiments and its blood was inoculated into susceptible pigs at three monthly intervals for a year but the blood did not at any time produce a reaction, so the animal was apparently not a carrier.

Pig 1180 was bled twice after passing through the reaction, at five months and at eight months. No reaction occurred when the blood was inoculated into susceptible pigs. A susceptible pig was placed in contact with 1104 foı several months but did not show any sign of a reaction.

### *Conclusions.*

The existence of carriers was demonstrated in a number of pigs which had survived swine fever outbreaks in the Western Province which had occurred up to eight months previously.

## APPENDIX VI.

*Experimental work carried out on mice and guinea-pigs* in the attempt to transmit swine fever to them.

For all the inoculations on mice a quantity of ·05 c.c. was used and for guinea-pigs ·1 c.c.

*Experiment* 1.

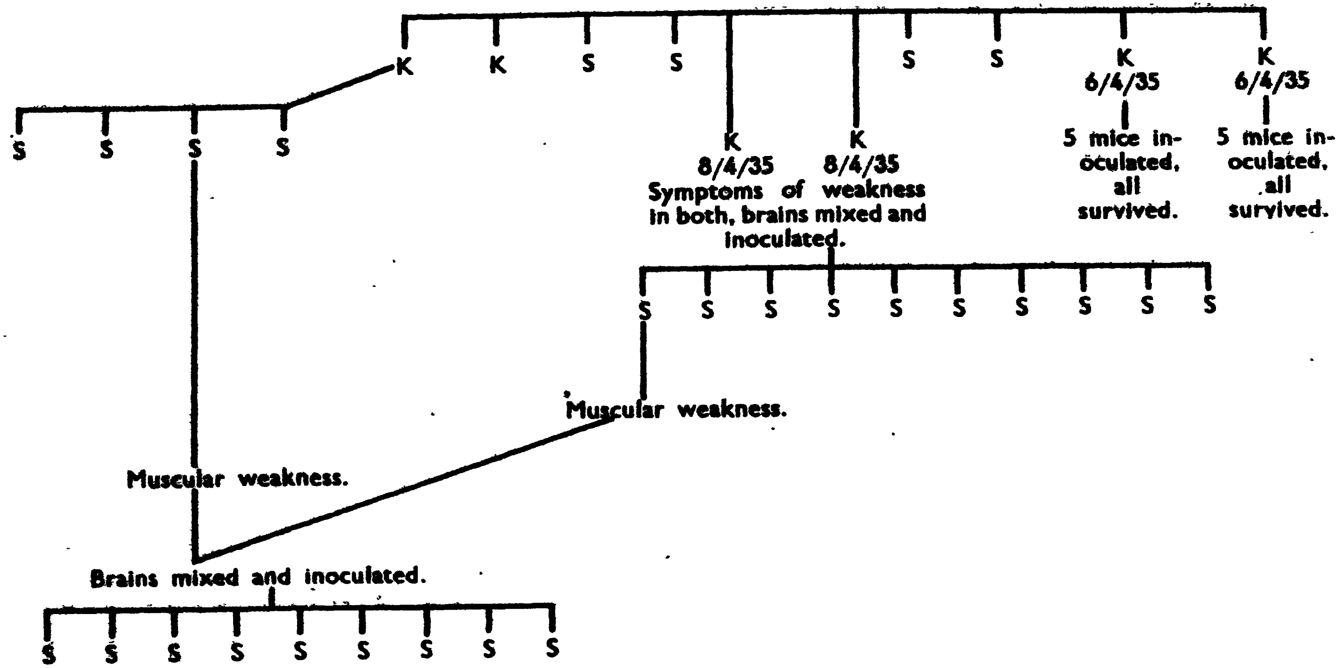
Defibrinated blood was taken from a pig 1059 on 28th March, 1935, immediately after death. The particular strain is referred to elsewhere in the swine fever experiments as the Savoy Estate one.

Ten white mice were inoculated intracerebrally, each with ·05 c.c. of defibrinated blood on 28th March, 1935. On 5th April, 1935, two of the mice were killed and the brains removed. The brains were emulsified in normal saline, using 20 c.c. to each brain, and ·05 c.c. of each of the two inoculated into 5 more mice. On 17th April, 1935, twelve days later, one of the mice from one lot showed muscular weakness, so it was killed and its brain added to that of a mouse showing weakness in another sub-inoculated lot from mice in the original ten. No symptoms developed subsequently in the sub-inoculated mice. Two other mice of the original ten were killed although showing no symptoms, and their brains inoculated into mice without results. The inoculations of the mice are schematically represented in Table I.

The surviving mice were all kept for at least twenty days after inoculation in order to see whether symptoms would develop.

TABLE I.

Ten mice inoculated intracerebrally with ·05 c.c. defibrinated blood of Pig 1059 on 28 March, 1935.


K
K
S
S
K
8/4/35
K
8/4/35
Symptoms of weakness in both, brains mixed and inoculated.
S
S
K
6/4/35
5 mice inoculated, all survived.
K
6/4/35
5 mice inoculated, all survived.
S
S
S
S
S
S
S
S
S
S
S
S
S
S
Muscular weakness.
Muscular weakness.
Brains mixed and inoculated.
S
S
S
S
S
S
S
S
S

S = survived.
K = killed.

*Experiment* 2.

Defibrinated blood was taken from a pig 1096 on 24th June, 1935, shortly after death.

Ten white mice were inoculated intracerebrally on 24th June, 1935, each with ·05 c.c. of defibrinated blood. Five of the mice received an intramuscular inoculation of ·05 c.c. of India ink as well. The ink was given with the idea of reducing the resistance of the animals.

On 1st July, 1935, seven days after inoculation, one mouse injected with ink and one which had not, were killed and a mixture of the brains inoculated into six mice, intracerebrally. One of these showed weakness on 6th July, 1935, and was killed, six more being inoculated with its brain. On 12th July, 1935, two of the apparently healthy mice were killed, and a mixture of their brains inoculated into seven mice intracerebrally. One of these mice died on 18th July, 1935, and its brain was inoculated into five mice intracerebrally. On 6th August ,1935, two of the inoculated mice showing signs of weakness were killed. A mixture of their brains was inoculated into six mice intracerebrally but these animals did not show any symptoms subsequently.

Table II shows a schematic representation of the inoculations.

*Experiment* 3:

In addition to the mice, six half-grown guinea-pigs were inoculated intracerebrally each with ·1 c.c. defibrinated blood from pig 1096 on 24th June, 1935. On the day of inoculation and on the following day each guinea-pig was given ·5 c.c. of India ink intramuscularly.

One of these guinea-pigs died on 30th June, 1935, and its brain was inoculated intracerebrally into four more half-grown guinea-pigs. These animals did not show any symptoms subsequently. Two of the other guinea-pigs were killed on 5th July, 1935, and their brains removed. A mixture of these two brains was emulsified in saline and four more guinea-pigs inoculated intracerebrally. These guinea-pigs remained healthy. No success attended the attempt to infect six white mice intranasally. Temperature charts were kept of the first six guinea-pigs, but apart from an initial rise of temperature in the first 24 to 48 hours the temperatures remained normal.

*Experiment* 4:

To see whether the virus inoculated into the brains of mice could maintain itself or whether it disappeared.

Two pigs were inoculated with brain material from a mouse and a guinea-pig. One pig, 1103, was inoculated subcutaneously with the whole brain of a mouse inoculated eight days previously with virulent swine fever blood. The other one, 1104, was inoculated subcutaneously with the whole brain of a guinea-pig inoculated eight days previously with virulent swine fever blood. In neither case did any temperature reaction or other symptoms occur in the following six weeks.

Two pigs, 1101 and 1102, were inoculated on 12th August, 1935, each with 5 c.c. of an emulsion of the brain of a mouse inoculated four days previously. This mouse was one of the fourth generation of sub-inoculations from virulent blood (see Expt. 2). No symptoms developed subsequently in either of the pigs and both subsequently died of swine fever when tested for immunity.

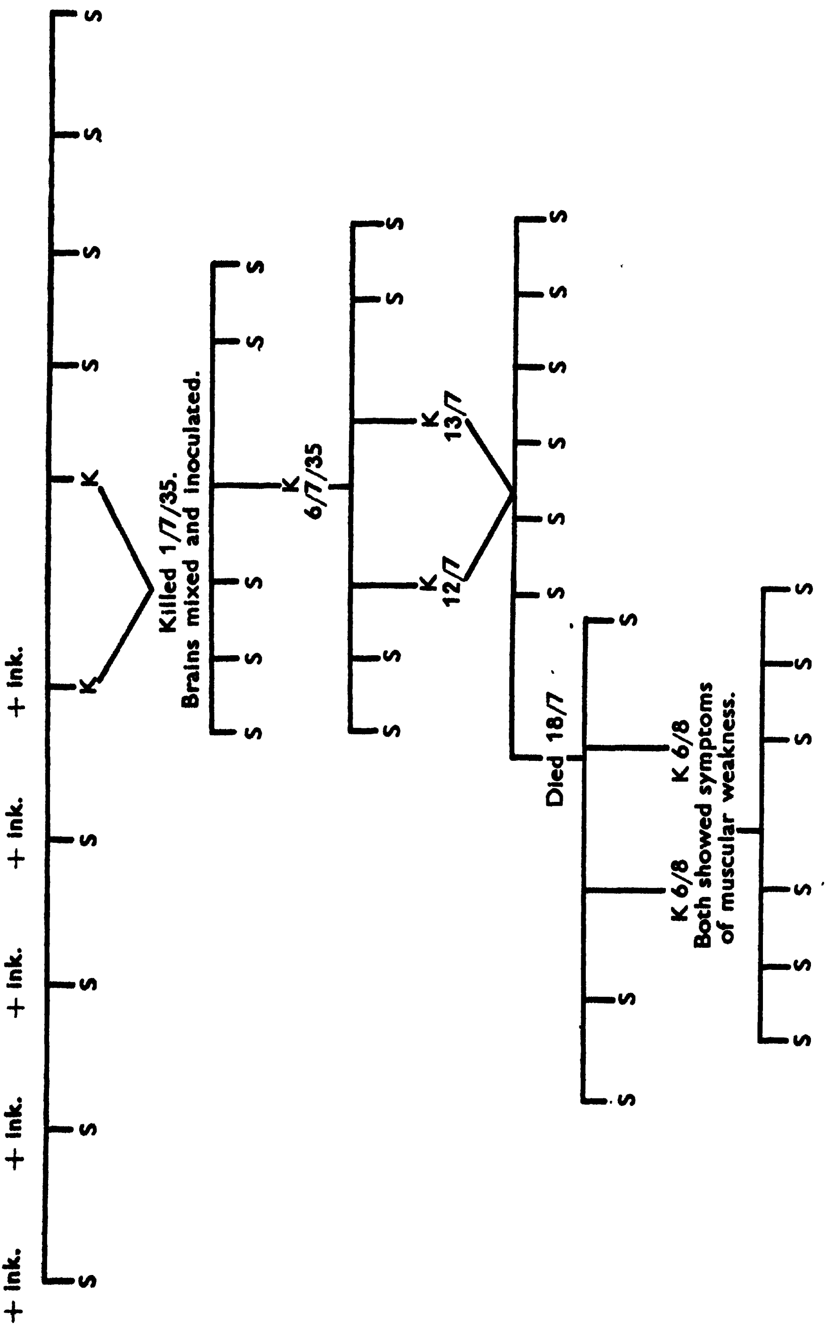
Two pigs, 1105 and 1106, were inoculated subcutaneously each with 5 c.c. of an emulsion of the mixed brains of two mice killed for transmission experiments. These mice were in the third generation from virulent blood (see Expt. 2). No symptoms were noted in the pigs for two months, when they were exposed to swine fever infection and one died, the other recovering after a very severe reaction.

## *Conclusions.*

No success attended attempts to transmit the virus of swine fever to laboratory animals.

TABLE II.

Ten mice inoculated intracerebrally with ·05 c.c. defibrinated blood of pigs 1096 on 24th June, 1935.



## APPENDIX VII.

### *Experiments on immunization of pigs against swine fever.*

*Experiment* 1:

Virus incubated with crystal violet solution for 14 days at 37·5° C. was inoculated subcutaneously into two pigs, 1078 (1 c.c.) and 1081 (5 c.c.). These pigs did not show any reaction for two months. They were then tested to see if any immunity had developed. Both developed acute swine fever and died on 7th day after inoculation. As the result of this test indicated that the virus had apparently been rendered completely inactive in 14 days and the inoculated pigs had developed no immunity, it was decided to try the virus incubated with crystal violet for a shorter period.

*Experiment* 2:

Two pigs, 1149 and 1150, each received 5 c.c. subcutaneously of a virus-crystal violet mixture incubated at 37·5° C. for 7 days. Both pigs died of acute swine fever on 7th day after inoculation. The period of 7 days incubation did not have any effect on the virus.

*Experiment* 3:

A pig was inoculated subcutaneously with 5 c.c. of a sample of defibrinated blood from a case of African swine fever at the height of the reaction and which had been incubated with crystal violet solution for 10 days. The pig died on 5th day after inoculation from the acute disease.

*Experiment* 4:

The same material as was used in experiment 3 was incubated for 10 days and then 5 c.c. were inoculated into pig 1170 subcutaneously. The pig died on 6th day from swine fever.

The few preliminary experiments described do not give any indication as to the value of crystal violet vaccine for swine fever immunization. In the one experiment where the virus was avirulent after 14 days incubation, there was no immunity conferred on the pigs.

The time taken to attenuate the virus appears to be variable. Further experiments on the action of crystal violet vaccine on pigs should be carried out though it seems unlikely that any method of immunization will produce a durable immunity in this disease.

### *Conclusions.*

No success attended attempts to immunize pigs against swine fever of the S. African "strain" by the crystal violet method of Dorset.

## APPENDIX VIII.

### CONTROL MEASURES.

The control of an infectious disease like Swine Fever in the Union of South Africa is hampered by many difficulties, e.g., distance between farms and between farms and markets, lack of proper hygiene and sanitation, lack of control (only a small proportion of pigs are kept in styes), the large veterinary areas, large numbers of European and Native owners, especially in Northern Transvaal, the wild pig as a carrier of the virus in certain areas, etc. Control and eradication of this disease were more or less effected on the following lines:—

(1) According to the provisions of the Stock Diseases Act every suspicion of Swine Fever, and in fact every mortality in pigs where a number of animals had died suddenly, had immediately to be reported.

(2) Immediately swine fever or suspicious cases occurred on a farm or elsewhere, the farmer or owner of the pigs had to stop the movement of pigs, meat, offal, etc., from his farm or property. All meat used on such a farm or property had to be boiled.

(3) The farmer or owner had to take immediate steps to report to his neighbours any suspected cases of Swine Fever on his farm or property. No affected pigs were allowed to be treated or slaughtered on such farms or properties, but were placed under effective control in yards or pens. The owner had to do everything in his power to prevent swine fever from being carried to uninfected farms or properties, by disinfecting as far as possible shoes, hands, implements, etc., coming in contact with infected pigs.

(4) If the veterinary officer or his representative had diagnosed Swine Fever, the affected farm was immediately placed under quarantine, and all the pigs on it placed under strict control. A valuation was made of all the pigs, and authority obtained from the Minister for slaughter with compensation on the scale prescribed in the Stock Diseases Act. valuation being made on existing market prices. The Department had to be satisfied that the owner took all precautionary measures and destroyed and buried all pigs according to prescribed instructions.

(5) The farmer had to do everything in his power to disinfect or burn out the styes and remove the dung from the styes for use as manure on land not utilised for pigs.

(6) No new pigs were introduced for a period of at least three months after the farm had been cleared of pigs.

(7) Restocking of the farm or property was only allowed from uninfected farms or properties under permit. The chief veterinary officer had to satisfy himself that all due precautionary measures had been taken. The introduction of new pigs were carried out gradually. All pigs passed through a system of quarantine pens, in which they were confined for at least three weeks before being introduced into the herd.

(8) No pigs were allowed to be moved out of any area declared infected with Swine Fever unless the person in charge had written permission from the Veterinary Officer. All vehicles used for the transport of these pigs were thoroughly disinfected immediately after use.

(9) No person was allowed to have access to swine affected or suspected of being affected with Swine Fever unless it was a person whose access was necessary for the proper care and treatment of such swine, or an officer acting under the powers of the Act or the regulations.

(10) No person who was in contact with swine affected or suspected of being affected with Swine Fever was allowed to approach other swine, or leave the place until his hands and boots (or, in the case where boots are not worn, his feet) were properly disinfected.

(11) It was the duty of the person in charge of swine which had been in contact with other swine suffering from Swine Fever to isolate the same for such a time and in such a manner as the Government Veterinary Officer prescribed.

(12) No person was allowed to move manure or litter from premises occupied by swine suffering or suspected to be suffering from Swine Fever except by permission of the Government Veterinary Officer and subject to such precautions as he prescribed.

(13) No hair, claws, heads, offal, excreta, or any other products derived from pigs was allowed to be moved out of or from any one place to any other place within any area declared infected with Swine Fever, except on the authority of a permit issued by the Government Veterinary Officer and subject to such conditions as he might impose.

(14) When Swine Fever had died out on a farm or property and a number of pigs had survived, such farm or property was kept under quarantine and no pigs were allowed on it unless all the remaining pigs were either destroyed or removed, under permit, to an approved abattoir for slaughter.

(15) As wild pigs (warthogs and bush pigs) and domestic pigs which have become wild, may become carriers of the virus of Swine Fever, all possible measures had to be taken to eradicate them from farms or properties in infected areas.

According to Administrator's Proclamation No. 40 of 1936, both warthogs and bush pigs were classed as vermin in the Transvaal and farmers were urged to destroy them.

(16) *Vigilance Committees* of farmers' associations were established in the quarantine areas to assist the Department:—

(*a*) By making propaganda amongst the farmers in their areas as regards the importance of *carriers* of African Swine Fever, symptoms of the disease, post-mortems, changes, regulations etc.

(*b*) By working in close association with the Government Veterinary Officer of the district in an advisory capacity and to persuade farmers to report immediately suspected outbreaks of the disease in pigs to the Veterinary Officer of the district, to assist in the control of illicit movements, to obtain information from farmers as regards occurrence of wild pigs, to assist the Department in the destruction of such wild pigs, and to compile a census of pigs in the quarantine areas.

The following Movement Notices were published to control Swine Fever:—

1. For the Western Province:
   G.N. 616 of 11.5.1931.
   G.N. 715 of 1.6.1934.
   G.N. 342 of 13.3.1936.
   G.N. 1740 of 20.11.1936.
   G.N. 1950 of 31.12.1936.
2. For the Witwatersrand (Transvaal):
   G.N. 314 of 16.3.1934.
3. For the Northern Transvaal:
   G.N. 636 of 10.5.1935.
   G.N. 920 of 28.6.1935.

In Northern Transvaal the Magisterial Districts of Pietersburg, Zoutpansberg, Lydenburg, Potgietersrust, Waterberg and Letaba were declared an area infected with swine fever and from there the movement of swine is only permitted to the quarantine section of an approved abattoir for immediate slaughter.

This legislation was provided to curtail the movements of swine from an area believed to harbour warthogs and bush pigs, amongst which a limited number may be carriers of swine fever virus.

# Section III.

# Parasitology.

Ortlepp, R. J. ... ... South African helminths VII. Miscellaneous helminths, chiefly cestodes 97

Mönnig, H. O. ... ... Treatment against lungworms (*Dictyocaulus filaria*) in sheep ... ... ... ... 111

Mönnig, H. O. ... ... *Marshallagia marshalli* (Ransom, 1907) Orloff, 1933, and a new species of this genus from sheep in South Africa 115

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# South African Helminths, Part VII. Miscellaneous Helminths, chiefly Cestodes.

By R. J. ORTLEPP, Section of Parasitology, Onderstepoort.

## CATENOTAENIA CAPENSIS SP. NOV.

A single specimen was collected from the Striped Mouse. The specimen was 23 m.m. long with a maximum breadth of 2·0 m.m. towards its posterior end; immediately behind the scolex the body breadth is just over 1 m.m. The scolex (Fig. 1) in comparison with the body breadth immediately behind it, appears to be relatively small; across the suckers it is 0·41 m.m. wide. The suckers are roughly circular, their external apertures being 0·084 to 0·095 m.m. across, and their diameter including the musculature 0·18 m.m.; each sucker is separated from that adjoining it by a groove. A rostellum and hooks are absent. The first genital anlage appears 0·16 m.m. behind the scolex, so that this portion of the strobila, between the scolex and anlage, may be considered to form a very short and broad neck. No external signs of segmentation are apparent opposite the first few anlages; when these anlages are considered to represent segments then the whole strobila is composed of 49 segments, of which the anteriormost are much broader than long, the ratio gradually changing posteriorly until the posterior is longer than broad.

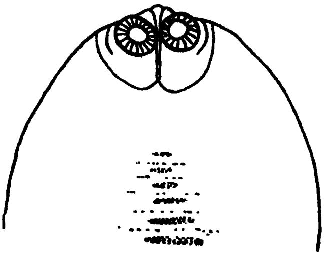

Fig. 1.—*Catenotaenia capensis* sp. nov. Anterior extremity.

The excretory system consists of a number, about 20, of longitudinal canals which give rise to a branching network; probably these canals represent a much developed ventral canal system, as the outermost of these longitudinal canals limit the lateral extension of the tests and uterus.

Mature segments (Fig. 2), which are slightly more than twice as broad as long, occur in the 24th to the 28th segments; these segments are from 1·75 to 1·9 m.m. broad. The genital pores are not prominent and are situated near the anterior margin of the segment; they alternate irregularly.

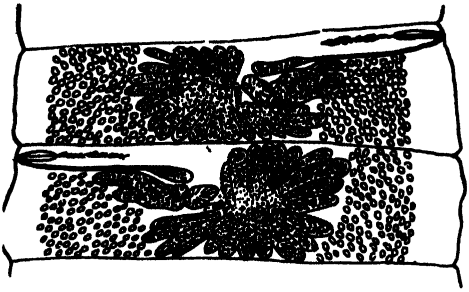

Fig. 2.—*Catenotaenia capensis* sp. nov. Mature segments.

The cirrus sac appears to be weakly muscular and consequently is not a well defined structure in the toto mount; it is almost 0·15 m.m. long by 0·05 m.m. thick. The cirrus is thick and smooth and has a thickness of 0·04 m.m. After emerging from the cirrus sac the vas deferens forms a coiled and transversely elongate mass. The testes, of which there are between 200 and 250, are arranged in an aporal and a poral group; the aporal group extends through the length of the segment, and the poral group from the anterior level of the yolk gland to the posterior segment margin; the groups are completely separated by the female glands, no testes being present behind the ovary. The vagina opens behind the aperture of the cirrus sac and passes almost transversely inwards; its inner portion is expanded to form a prominent receptaculum seminis which persists even in the oldest segments; in mature segments it is sausage-shaped, 0·18 to 0·2 m.m. long and 0·34 to 0·05 m.m. thick, and in the hindmost segments it is oval and about 0·25 m.m. long and 0·14 m.m. thick. The ovary is a large fan-like structure with long lobules; its aporal portion which is the largest, extends from the anterior to the posterior margin of the segment and its poral portion passes laterally between the yolk gland and the posterior margin of the segment. The yolk gland lies anterior of the poral portion of the ovary and posterior of the receptaculum seminis and vagina; it is a transversely elongate massive structure with shallow lobes and is from 0·3 to 0·36 m.m. long by 0·15 to 0·18 m.m. broad. The shell gland is roughly oval, measuring 0·12 to 0·144 m.m. by 0·084 to 0·096 m.m. and lies next to the yolk gland, between it and the ovary. The uterus makes its first appearance in the 28th segment as a median stem; transverse branches on either side soon appear, so that in older segments we find a uterus very similar to that found in members of the genus *Taenia*, consisting of a thin main stem and long transverse branches (Fig. 3); there are 10 to 13 main branches on either side of the main stem and these may subdivide towards their periphery. A well defined, branching, uterus is present from the 32nd segment backwards; the oldest segment is 2·28 m.m. long by 1·85 m.m. broad, but contains no fully developed eggs, so that it would appear that the segments are shed before they are completely ripe.

*Affinities*.—The above described species resembles *C. lobata* Baer, 1925, *C. symmetrica* Baylis, 1927, and *C. geosciuri* Ortlepp, 1938, in that the excretory system forms a network of anastomosing canals; in this respect it differs from *C. pusilla* (Goeze, 1782) and *C. dendritica* (Goeze, 1872). The central position of the yolk gland behind the ovary, and the presence of testes behind the ovary distinguishes Baylis' species from the writer's. *C. geosciuri* differs from the above described species in the elongate nature of its segments, the massive development of its vagina, the position of its testes all posterior of the female glands, and the sacculated nature of its uterus. Its closest relative appears to be *C. lobata*, with which species it agrees in the number of testes and large fan-like ovary. Baer's species differs, however, in that the testes meet posterior of the ovary and the poral portion of the ovary passes between the yolk gland and the anterior margin of the segment, and not between the yolk gland and posterior margin of the segment as in the species described above.

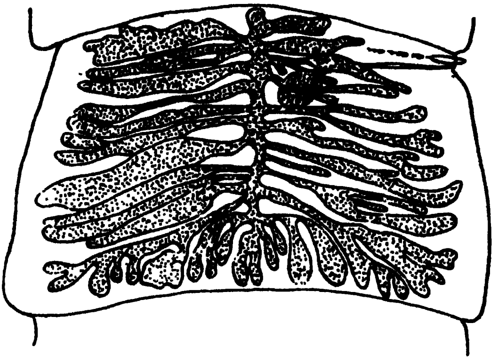

Fig. 3.—*Catenotaenia capensis* sp. nov. Ripe segment.

*Specific Diagnosis*.—Dipylidinae reaching a length of at least 23 m.m. by 2·0 m.m. broad. Segments, except for the posteriormost, broader than long. Neck much broader than scolex. Excretory system a network of anastomosing canals. Genital pore near anterior margin of segment. 200 to 250 testes in an aporal and poral group, no testes joining these groups behind ovary. Ovary large and fan-shaped filling central portion of segment; poral portion of ovary passes between yolk gland and posterior margin of segment. Receptaculum seminis large. Yolk gland massive, anterior of poral portion of ovary Uterus with thin median longitudinal stem and 10 to 13 long lateral main branches on either side. Eggs not observed.

Host: *Rhabdomys pumilio vittatus* (Wagn).

Habitat: Small intestine.

Locality: Stilbaaistrand, C.P.

Type (mounted) in Onderstepoort Helminthological Collection.

## DILEPIS SPHAEROCEPHALA (Rud., 1819), Meggitt, 1924.

Numerous specimens were collected from several Golden Moles. These specimens are tentatively referred to the above species, the data given in brackets being those given by Janicki (1906). The complete strobilae measure 21 to 22 m.m. in length with a maximum thickness of 1·8 m.m. (1·36 m.m.); according to Dujardin's (1845) interpretation of Rudolphi's data fragments may reach a length of 54 m.m. by 2·25 m.m. broad. All the segments are much broader than long; ripe segments have the greatest length and these are 0·27 to 0·3 m.m. long by 1·8 m.m. broad. The scolex (Fig. 4A) is large (very large) measuring 0·72 m.m. (0·578 m.m.) across by 0·36 m.m. in length. The prominent suckers are unarmed and are directed obliquely forwards; they have a diameter of 0·264 to 0·288 m.m. The rostellum is 0·12 to 0·132 m.m. long by 0·22 to 0·23 m.m. across (strongly developed); and carries 44 to 48 hooks; these are arranged in two circles, and all the hooks are practically the same size and have the same shape (Fig. 4B and C); the anterior hooks are, however, slightly shorter; the anterior hooks measure 0·06 to 0·075 m.m. in length, and the posterior hooks 0·068 to 0·077 m.m. A neck is practically absent (absent), segmentation commencing almost immediately posterior of the scolex; here the strobila has a width of 0·6 to 0·67 m.m.

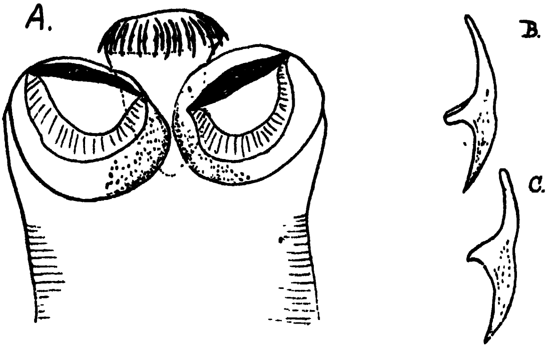

Fig. 4.—*Dilepis sphaerocephala* (Rud). A = Scolex; B = Posterior hook; C = Anterior hook.

The longitudinal musculature is well developed and consists of two layers of bundles of which the bundles of the outer layer are smaller and more numerous; each bundle consists of about 15 to 20 fibres.

The unilateral genital pores are situated in the anterior half of the segment. The genitalia consist of a transversely elongate and centrally placed lobulate ovary with about 20 testes arranged laterally, dorsal, ventral and behind it. The cirrus sac is sausage-shaped, 0·12 to 0·132 m.m. long (0·132 m.m.) and 0·036 m.m. thick; it extends beyond the excretory canals (in Janicki's Figures 32 and 33 the cirrus sac is shown extending over the ventral excretory canal in one and not reaching it in the other). The cirrus is spined and convoluted in the cirrus sac; the vas deferens forms voluminous coils after emerging from the cirrus sac and is enlarged to act as a vesicula seminalis. The vagina lies dorsal (*vor*) of the cirrus sac and opens into the genital sinus dorsal of this organ; this is an exceptional state of affairs but this arrangement was shown in all the serial sections and toto mounts examined; the vagina is slightly wavy, has a diameter of 0·017 m.m. and is surrounded by prostatic cells; its inner portion is terminated by a median elongate receptaculum seminis. The uterus is a transverse lobulated sac, which in ripe segments practically fills the whole segment, extending laterally over the excretory canals especially on the poral side. The eggs have two coats, an outer which is very thin and has a diameter of 0·072 to 0·075 m.m. (0·05 m.m.) and an inner thicker chitinous coat, 0·03 to 0·033 m.m. in diameter; the onchosphere practically fills this inner shell and its hexacanth hooks are 0·017 m.m. long.

*Affinities*.—Notwithstanding the fact that the writer's material appears to differ in some respects from Janicki's redescription of this species, the writer nevertheless feels that the two materials are cospecific; the points in which these two materials differ are the differences in the size of the scolices, apparently different position of the vagina (anterior to the cirrus sac in Janicki's and dorsal of this organ in the writer's materials) and the difference in size of the eggs; they agree, however, in that the scolex is large, the rostellum well developed, a neck is practically absent, the segments are all much broader than long, the musculature is of the same type and equally well developed, the genital glands are similar, the cirrus sacs are of the same size, the vas deferens is much coiled and enlarged, the uterus fills practically the whole segment and the materials originate from the same host.

We are in agreement with Magitt that this species belongs to the genus *Dilepis* and not the genus *Hymenolepis* as suggested by Blanchard (1891) or *Raillietina* as listed by Baer (1927).

Host: *Chrysochloris asiatica* (Linn).

Location: Small intestine.

Locality: Newlands and Wynberg, Cape Province.

## DILEPIS MEGACIRROSA SP. NOV.

This species was recovered from two golden moles, once (four specimens) in association with the previous species, and once (fair number of specimens) by itself. The largest specimens, reaching a length of 10 m.m., were those found in association with *D. sphaerocephala*; the specimens of the pure infection were considerably contracted.

Complete specimens varied in length from five to 10 m.m. according to the state of contraction, and the maximum width of the strobila varied from 0·96 to 1·14 m.m. All the segments are much broader than long, but the ripe segments tend to become proportionately much longer than those anterior of them; ripe segments vary in length from 0·144 to 0·24 m.m.

The scolex is very similar to that of *D. sphaerocephala;* it has a transverse diameter of 0·5 to 0·54 m.m.; the suckers measure 0·18 to 0·21 m.m. across and the thickness of the rostellum varies from 0·21 to 0·26 m.m. There are 44 to 50 rostellar hooks arranged in two rows; they have the same shape as those of *D. sphaerocephala* but are slightly larger; the anterior hooks are from 0·072 to 0·084 m.m. in length and the posterior hooks vary in length from 0·085 to 0·092 m.m. A neck is practically absent, only 0·12 m.m. of the strobila behind the scolex showing no signs of segmentation; this portion has a breadth of 0·42 to 0·48 m.m.

The muscular system is very poorly developed, and consequently the strobilae are semitransparent and can thus easily be separated from those of *D. sphaerocephala;* the longitudinal muscles are represented by a few isolated fibres scattered through the inner portion of the cortex; the transverse muscles also consist of a few isolated fibres. The usual two longitudinal excretory canals are present and these show no special peculiarities; in section of mature segments the average diameter of the dorsal canals is 0·006 m.m. and that of the ventral canals 0·012 m.m.

The genital pores are unilateral and not prominent and are lodged in the anterior half of the segment, just anterior of its middle. The cirrus sac is a long and weakly muscular organ extending about one third of the distance across the segment; it is from 0·25 to 0·3 m.m. long by about 0·045 m.m. in thickness; it and the vagina pass dorsal of the central excretory canal and nerve; the cirrus sac lodges a relatively large cirrus which when extruded may reach a length of 0·3 m.m.; the cirrus is covered by minute spines and has a basal thickness of about 0·03 m.m. and tapers off to a thickness of about 0·016 m.m.; a very striking feature of practically all the strobilae is that the cirri are extruded and under a low magnification give the strobilae a frilled appearance along one edge. The vas deferens, after emerging from the cirrus sac, is very much coiled in a manner similar to that found in *D. sphaerocephala;* it is also much enlarged and serves as a vesicula seminalis. There are about 15 testes to each segment, two to three layers deep; of these four to six are poral in position, five to seven aporal and the rest dorsal of the ovary; in mature segments they have a diameter of about 0·06 m.m. The vagina is slightly convoluted with an enlarged lumen which is provided with a cuticular lining for its whole length; its inner terminal portion is enlarged to form a fusiform receptaculum seminis; the vagina lies dorsal of the cirrus sac but its opening into the genital sinus may be either dorsal or posterior of this organ. The ovary is a multilobate centrally placed organ, occupying about one third of the width of the segment. The sac-like uterus, when fully formed, fills practically the whole segment and may extend lateral of the excretory canals. The contained eggs lie closely packed in its lumen and the diameter of their outer covering varies from 0·066 to 0·072 m.m. and that of the thicker and firmer inner coat 0·039 to 0·042 m.m. The onchosphere has a diameter of 0·033 m.m. and the length of its hooks are 0·017 to 0·018 m.m .

*Affinities.*—This species possesses many characteristics which show that it is closely related to *D. sphaerocephala;* these are the nature of the scolex, rostellum and hooks, the organisation of the genital glands and the relative position of the vagina to the cirrus sac; it differs from this species however, in that the strobila is smaller, the rostellar hooks slightly larger, the musculature is very poorly developed, the cirrus sac and cirrus are considerably larger and the uterus is not lobed.

*Specific Diagnosis.*—Dilepidinae reaching a length of 10 m.m.; rostellum with double row of 44 to 50 hooks, anterior hooks up to 0·084 m.m. long, posterior hooks up to 0·092 m.m. long; musculature very poorly developed and strobila semi-transparent; cirrus sac up to 0·3 m.m. long; cirrus armed, large up to 0·3 m.m. long and generally extruded; about 15 testes; vagina dorsal of cirrus sac and opens dorsal or behind it into genital sinus; uterus sac-like and filled with numerous eggs.

Host: *Chrysochloris asiatica asiatica* (Linn).

Location: Small intestine.

Locality: Vicinity of Cape Town (Newlands), Cape Province.

Types in Onderstepoort Helminthological Collection.

## BIUTERINOIDES UPUPAI gen. and sp. nov.

The material available consisted of one scolex and neck, one scolex and portion of strobila, 47 m.m. long, two anterior portions of two strobilae, 36 and 45 m.m. long respectively, one central portion of a strobila, 41 m.m. long, one posterior portion of a strobila 22 m.m. long and several other smaller portions of strobilae. If the central and posterior portions of strobilae belong to the strobila with head, then the length of the worm reaches 110 m.m. The segments are all wider than long, mature segments being 0·45 to 0·5 m.m. broad by 0·18 to 0·19 m.m. long; posteriorwards the segments become gradually longer; the hindmost segment of the strobila plus head is 0·84 m.m. broad and 0·48 m.m. long; detached segments, apparently ripe are somewhat barrel-shaped, 1·15 m.m. broad and 1·0 m.m. long.

The scolex is somewhat pear-shaped 0·72 m.m. in width by 0·48 m.m. long. The suckers are rounded and unarmed, the muscular portion having a diameter of 0·24 m.m. and their external orifices being slightly oval, measuring 0·084 by 0·12 m.m. The rostellum is fully retracted in both scolices and in this position measures 0·168 m.m. in breadth by 0·12 m.m. in length. The number and nature of the hooks could not be ascertained in the cleared heads, consequently one of the heads was teased up; this head showed the presence of 77 hooks arranged in four irregular rows; the hindmost hooks (Fig. 5A) are the longest and have the typical triangular shape and measure 0·035 to 0·041 m.m. in length by 0·02 to 0·028 m.m. across their base; the hooks of the 2nd, 3rd, and 4th rows (Fig. 5B, C and D) are somewhat pear-shaped; those of the 2nd row are 0·024 to 0·03 m.m. long and 0·011 m.m. thick across their base; those of the 3rd row are 0·017 to 0·021 m.m. long and 0·007 to 0·008 m.m. thick across their base, and the hooks of the 4th row 0·011 to 0·015 m.m. long by 0·0045 to 0·005 m.m. across their base.

A neck is present, just over 2·0 m.m. in length by 0·54 m.m. in breadth. The genital pores alternate irregularly and are situated at about the junction of the first and second thirds of the segment margin. A dorsal and a ventral longitudinal excretory canal are present on either side; the former has a slightly thickened wall and a diameter of about 0·006 m.m.; the latter is much wider and thin-walled, its diameter varying from 0·03 to 0·042 m.m. The genital ducts pass between the excretory canals.

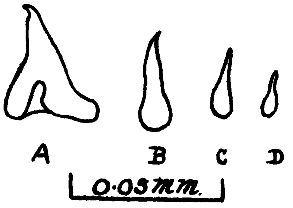

Fig. 5.—*Biuterinoides upupai* gen. et. sp. nov. Hooks from scolex. A = Hindmost hook; B = Hook from 2nd row; C = Hook from 3rd row; D = Hook from posterior row.

The cirrus sac is somewhat flask-shaped with a long neck, it is 0·12 to 0·132 m.m. long by 0·042 in diameter and reaches and sometimes passes between the longitudinal excretory canals; a *vesicular seminalis interna* and *externa* is absent. There appears to be about 10 testes to each segment, four to five poral and five or six aporal in position, lateral of the female glands; unfortunately they take up stain very lightly so that it is with difficulty that they can be made out; their diameter appears to be about 0·04 m.m. in mature segments.

The ovary is a large centrally placed two-lobed transverse organ, measuring 0·13 to 0·15 m.m. across and 0·042 to 0·05 m.m. in length; immediately behind it is a large and irregularly shaped yolk gland measuring 0·07 to 0·09 m.m. across and 0·03 to 0·04 m.m. in length. The uterus is first formed as a transverse sac in the posterior half of the segment; as the segments grow older a darker staining mass of cells appears in the anterior half of the segment, and this mass eventually forms the paruterine organ. As this organ increases in size it assumes an hour-glass shape, presses on the anterior central portion of the uterus, with the result that the uterus becomes constricted in its middle and now appears like two isolated uteri (Fig. 6A), whose cavities are, however, always in communication with each other through the narrow isthmus; further growth backwards of the paruterine organ causes the uterus to send forwards two sacculations which become surrounded by the fibrous paruterine tissues (Fig. 6B); these two sacculations become the egg capsules and remain joined to each other by the much reduced original uterus posterior to the parutereine organ. In the hindmost segments which in the writer's material are all detached, the rounded egg capsules appear to be completely separated from each other (Fig. 6c), but careful observation show that a connection still exists between them in the form of the now entirely collapsed original uterus. The paruterine organ has also now become columnar in shape. The eggs, of which about 30 to 40 are present in each egg-capsule, have a thin loose outer covering having a diameter of 0·059 to 0·061 m.m.; the embryo has a diameter of 0·033 to 0·05 m.m. and is closely invested by a thin coat. The hexacanth hooks are relatively large, measuring 0·02 to 0·026 m.m. in length.

Numerous rounded chalk bodies are scattered in the cortical parenchyma of the whole length of the strobila; they are especially evident in the hindmost ripe segments, where they may reach a diameter of 0·025 m.m.

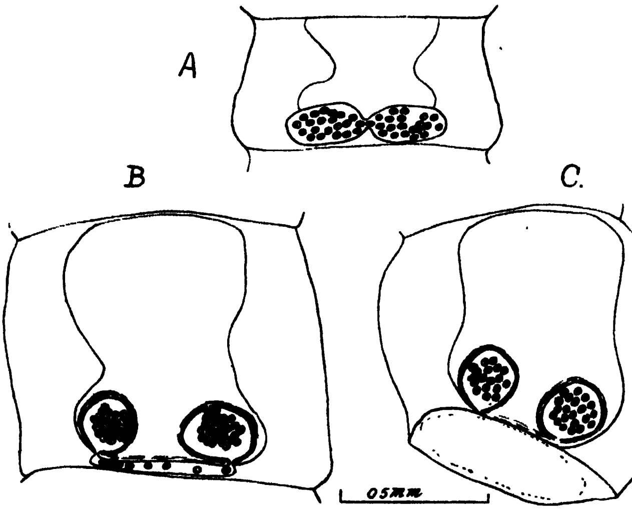

Fig 6.—*Biuterinoides upupai* gen. et. sp. nov. Showing different stages in the formation of paruterine egg-capsules.

*Affinities.*—The triangular shape of the largest hooks and the nature of the uterus clearly show that this species is closely related to the members of the genus *Biuterina* Fuhrmann. It differs, however, from all the known members of this genus, except *B. intricata* (Krabbe, 1882) in that the rostellar hooks are arranged in four rows; also in the writer's species the uterus eventually forms two egg-capsules enclosed by the paruterine organ. Three species of tapeworms have so far been described from upupiform birds, namely *Hymenolepis septaria* v. Linstow, 1906 *Biuterina lobata* Fuhrmann, 1908, and *Taenia intricata* Krabbe, 1882. The first named need not be considered here as it bears no close relationship to the writer's species. Fuhrmann, whose material unfortunately possessed no scolices, expressed the view that his species might be the same as Krabbe's, both of which were collected from the same species of host *Upupa epops*; the fact that Krabbe's species was described as carrying four rows of hooks deterred Fuhrmann from making a definite decision, especially as the typical number of rows of hooks in *Biuterina* is two and not four. Moghe and Inamdar (1934) examined material from the same host (India) and they were able to confirm Krabbe's observation as to the arrangement of the hooks and they concluded that Fuhrmann's and Krabbe's species were the same. The finding of the above described species also from an upipiform bird, is of special interest in that it also carries four rows of rostellar hooks. Another feature which these two species appear to have in common is the formation in fully ripe segments of two uterine egg-capsules enclosed by the paruterine organ; the oldest segments seen and figured by Fuhrmann and by Moghe and Inamdar show two distinct uteri, but these are still external and posterior of the paruterine organ; it is quite possible that these segments were not yet fully gravid and that older segments would have shown the formation of two egg-capsules enclosed by the paruterine organ, similar to those found in the writer's species. The writer's species can easily be separated from Krabbe's in that the latter species has fewer hooks (64) which are larger (0·0196 to 0·052 m.m.).

The disposition of the rostellar hooks in four rows and the presence of two egg capsules in the fully mature segments are to the writer of sufficient importance to warrant the creation of a separate genus for the reception of the writer's species; in order that its close affinity to *Biuterina* may be shown the writer proposes the name *Biuterinoides*. This genus would have the same characters as those of *Biuterina* except that the rostellar hooks are arranged in four rows instead of two, and the uterus gives rise to two egg capsules in the fully mature segment. The type species would be *Biuterinoides upupai* described above. To this genus the writer also assigns Krabbe's species *Taenia intricata;*

*Specific Diagnosis.*—Paruterinae reach a length of at least 47 m.m. and may perhaps exceed 100 m.m. Posterior rostellar hooks triangular and up to 0·041 m.m. long; hooks of second, third and fourth rows pear-shaped and smaller; total number of hooks ca. 80. Genital pores irregular alternate in anterior third of segment. Cirrus sac reaches and may extend between excretory canals. Testes about 10. Paruterine organ at first hour-glass shaped, later more or less columnar. Uterus gives rise to two apparently separate egg-capsules each containing up to about 40 eggs.

Host: *Upupa africana.*

Location: Small intestine.

Locality: Cape Province.

Types in the Onderstepoort Helminthological Collection.

### RAILLIETINA (RAILLIETINA) TRAPEZOIDES (Janicki, 1904).

Specimens recovered from the Striped Mouse [*Rhabdomys pumilio vittatus* (Wagn)] and Brant's Gerbil [*Tartera brantsi*

*brantsi* (A. Smith)] are referred to this species. The following table will serve to bring out the resemblances between Janicki's data and that obtained by the writer from the mouse and gerbil material.

| | Janicki. | Mouse. | Gerbill. |
|---|---|---|---|
| Number of hooks......... | 160 | 160 | 200–220 |
| Size of hooks............. | 0·008 m.m | 0·006–0·0075 m.m. | 0·007–0·009 m.m |
| Number of testes......... | 12–15 | 11–14 | 10–15 |
| Length of Cirrus sac...... | 0·105–0·132 m.m. | 0·12 m.m. | 0·12–0·162 m.m. |
| Thickness of Cirrus sac... | 0·052–0·07 m.m. | 0·06 m.m. | 0·06–0·084 m.m. |
| Number of egg capsules per segment............. | 30–50 | Ca. 60 | 60–80 |
| Eggs per capsule......... | 4–5 | 5–8 | 5–9 |
| Relation of Cirrus sac to Exc. Canal........... | Reaches excretory canal. | Does not reach excretory canal. | Does not reach excretory canal. |

From this table it is clear that the only striking differences are the greater number of hooks in the material from the gerbill and that in Janicki's material the cirrus sac reaches the excretory canal, which it does not do in the writer's materials. Notwithstanding these differences the writer considers his and Janicki's materials to be cospecific.

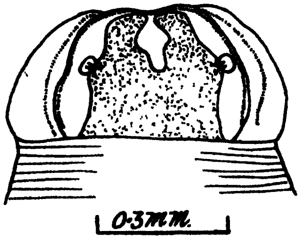

Fig. 7.—*Ascaris suricattae* sp. nov. Cephalic extremity showing structure of dorsal lip.

### ASCARIS SURICATTAE SP. NOV.

Five males, three females and an immature female were available for study; all had been recovered from two surricats. The males are 50 to 54 m.m. long by 1·0 and 1·2 m.m. thick respectively; the mature females are 67, 72 and 85 m.m. long and have a maximum thickness of 1·3 to 1·56 m.m. In both sexes the body is relatively slender, and the attenuation towards both extremities is gradual and about the same degree. The cephalic extremity is straight in both sexes. The posterior extremity is straight in the female and is terminated by a conical tail 0·48 to 0·624 m.m. long; in the males this extremity is bent ventralwards and the tail is 0·26 to 0·276 m.m. long. The head is slightly constricted off from the body; in the males it is 0·19 to 0·2 m.m. broad and 0·15 to 0·17 m.m. high and in the females about 0·3 m.m. wide and 0·19 to 0·24 m.m. high. Each lip carries a conspicuous dentigerous ridge along its inner border. The three prominent lips (Fig. 7) are slightly wider than long, and their anterior faces are somewhat flattened and indented in their middle. The pulp of the dorsal lip consists of a basal solid portion from which arises two conspicuous anterior lobes as in figure; its two papillae are large and single. The pulps of the lateral lips are very similar except that the dorsal lobe of the pulp is stouter and better developed than the ventral lobe; each lip carries a single simple papilla situated in its ventral half. Interlabia and cervical alae are absent. The oesophagus is simple and carries no appendages or bulb. In the males it is 3·6 to 3·7 m.m. long with a maximum thickness of 0·36 to 0·4 m.m.; in the female it is 3·6 to 4·2 m.m. long and increases gradually in thickness from 0·2 to 0·4 m.m. near its posterior end. The nerve ring encircles it at 0·48 m.m. from the anterior end. The vulva is a small aperture situated in the anterior body half at about the junction of the first and second body quarters or first and second body thirds. In two females which measured 67 and 72 m.m. in length its position was 14·5 and 23 m.m. from the anterior end respectively. The two uteri extend backwards and are filled with eggs; these appear to be rounded and measure 0·072 to 0·075 m.m. in diameter. From the eggs *in utero* it was not possible to determine the nature of the egg-shell, i.e. if it is smooth or rugose. The tail is 0·48 to 0·63 m.m. long and tapers in its posterior quarter to end in a bluntly rounded point.

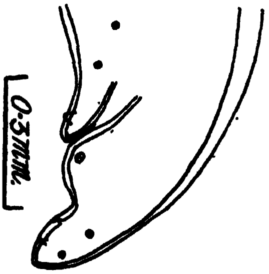

Fig. 8.

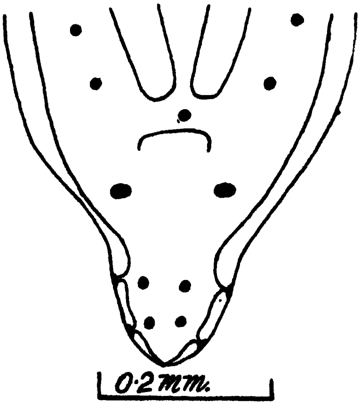

Fig. 9.

Fig. 8.—*Ascaris suricattae* sp. nov. Posterior extremity of male, lateral view.

Fig. 9.—*Ascaris suricattae* sp. nov. Ventral view of posterior extremity of male.

In the male the caudal extremity is bent ventralwards and alae are absent. The tail has a probular projection as in *Toxocara canis* [Werner (Fig. 8)], which projection is best seen in a lateral view; this projection forms slightly more than half of the total length of the tail. There are five pairs of post-cloacal papillae, of which three pairs are ventral and two pairs lateral (Fig. 9). The anteriormost ventral pair is double and is situated just behind the cloaca; the two remaining pairs are situated on the probular portion of the tail; the two lateral pairs of papillae are also situated on this portion of the tail. Anterior of the cloaca there is a single unpaired papilla and a row of 14-16 papillae extends forwards on either side. The two spicules, which were not exerted, appear to be simple; they are equal, measuring 1·14 to 1·2 m.m. long and end in bluntly rounded points.

*Affinities.*—If it were not for the absence of cervical alae, the above described species would be closely related to *Toxocara canis* (Werner, 1782). The nature of the pulp of the lips, the shape of the male tail and single papillae on the lips are very similar in these two species; the latter species, however, has, in addition to the cervical alae, much shorter spicules. Of the species of Ascaris, the species *A. lumbricoides*, *A. dasypodina* Baylis, 1922, *A. tarbagan* Schulz, 1931, and *A. hippopotami* Canavan, 1931, have double papillae on the lips. *A. columnaris* Leidy, 1856, and *A. joffi* Schulz, 1931, have single lip papillae. Only the female of the latter species is known and in it the anterior lobes of the pulp of the lips are different. According to Goodey and Cameron (1923) the male of Leidy's species also has a probular tail, but it differs from the writer's species in that the male tail is longer, the arrangement of the post colacal papillae is different, the number of precolacal papillae is greater and the spicules are much shorter.

*Specific Diagnosis.*—Ascarinae reaching a length of 62 m.m. in the male and 85 m.m. in the female. The three lips are anteriorly flattened and carry dentigerous ridges and single papillae; cervical alae and inter-labia absent. Vulva in anterior body half at junction of first and second body quarters or first and second body thirds. Female tail conical. Male tail bent ventralwards, probular and not provided with alae. Five pairs post-cloacal papillae, the first pair ventral and double, situated just behind cloacal aperture; the remaining four pairs on probular portion of tail, two pairs being ventral and two pairs lateral. Single, median papilla on anterior lip of cloaca; 14 to 16 pairs of lateral papilla extending forwards anterior of cloaca. Spicules simple, equal and similar, 1·14 to 1·2 m.m. long.

Host: *Suricata suricatta hamilton* (?) Thos. and Schw.

Location: Small intestine.

Locality: Carolina, Transvaal.

Types in the Onderstepoort Helminthological Collection.

## SUMMARY.

In the foregoing the writer discusses five species of Cestodes and one species of Nematode; of the cestodes three species are considered as new and the species from the Hoepoe is assigned to a new genus *Biuterinoides* closely related to the genus *Biuterina* Fuhrmann, 1902. The new species are *Catenotaenia capensis* from the Striped Mouse, *Dilepis megacirrosa* from the Golden Mole, *Biuterinoides upupai* from the Hoepoe and *Ascaris suricattae* from the Surricat. Another species of cestode from the Golden Mole is

identified as *Dilepis sphaerocephala* (Rud. 1819) and its morphology is described. Materials from the Striped Mouse and the Gerbil are referred to *Raillietina* (*Raill.*) *trapezoides* (Janicki, 1904).

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# Treatment against Lungworms (*Dictyocaulus filaria*) in Sheep.

By H. O. MÖNNIG, Section of Parasitology, Onderstepoort.

THE lungworm *Dictyocaulus filaria* is fairly widely distributed in the grassveld regions of the Union. It is only in a few small centres, however, that its presence is obvious, on account of the effects it produces. These are areas in which moist pastures favour the spread of infection. In the other parts the lungworms are usually not noticed at all, because they occur in very small numbers and do no damage, but their presence becomes noticeable during and after a wet season, such as occurred in the summer of 1938-39. In this year lungworms were seen to occur and to do damage even in the Transvaal Highveld, e.g., in the vicinity of Amersfoort, Volksrust and Wakkerstroom. It is very probable that a few summers with more normal rainfall will cause the worms to disappear again, or rather to recede into the background, in such areas.

On the whole, therefore, this lungworm is not a cause of serious trouble in the Union and, besides, it is known that if infected sheep are well fed and protected from adverse weather conditions most of them soon recover. The infective larvae are not resistant to desiccation and infection can therefore be avoided by keeping sheep from moist pastures. However, if a satisfactory method of treatment were available it would be useful, either to prevent losses where an infection flares up, or as a means of exterminating the parasites altogether.

Many methods of treatment have been described, but most of the older methods were discarded as useless. Only the method of intratracheal injection has still several supporters. It was particularly Orloff (1935) who, in recent years, aroused new interest in this method by stating that, since the worms were almost exclusively located in the posterior, dorsal parts of the lungs, the sheep has to be placed on its back, head upwards, in a trough-like receptacle which stands at an angle of 45° to the horizontal, so that the injected fluid would flow into the affected parts of the lungs. After the injection the sheep is kept in a sitting position for 20-30 seconds. He claimed very good results from two injections, on two succesive days, of 10 c.c. of the following mixture: 1 c.c. 10 per cent. tincture of iodine, 50 c.c. glycerine and 150 c.c. distilled water.

Subsequently other Russian authors confirmed these results, but there appeared to be a general preference for one injection of 15 c.c. of a mixture of iodine 1 part, potassium iodide 2 parts, water 1,500 parts.

In France Velu and Zottner (1937) used pyrethrin, giving three 10 c.c. doses of an aqueous solution containing 1 mgm. pyrethrin per dose. In this case the drug is administered through the nose, by means of a rubber tube measuring 12-15 cm. by 4.5 mm., the sheep being kept in a sitting position and thereafter on its back for a few seconds. Good results were also claimed for this method.

Some 12 years ago the writer tested various intratracheal injections and also gave a number of drugs *per os*, but none of them had any effect. Recently further tests have been made and it is intended to report on these now.

The tests were made on a farm in the Transvaal highveld, on a flock of sheep in which serious losses were occurring. The method used was that of Orloff. The needle was directed backwards in the trachea and each sheep was rolled over first to one side and then to the other, while the successive halves of the dose were being slowly injected so that each lung should get its portion.

*The first test* was made on 4.5.39. From a flock of affected animals 30 were selected which were coughing and in poor condition. About a teaspoonful of faeces was collected from each of them and placed in gauze, which was then suspended in a specimen tube containing about 20 c.c. lukewarm water. After two hours the gauze and faeces were discarded, about 2 c.c. concentrated formalin was added to the water and the specimens later examined at the laboratory.

The sheep were then treated as follows:—

No. 1. 16 sheep. 15 c.c.: Iodine 1, Potassium iodide 2, water 1,500.

No. 2. 10 sheep. 10 c.c.: Tincture iodine 1, Glycerin 50, water 150.

No. 3. 4 sheep. 10 c.c.: Tetrachlorethylene emulsion containing 0·5 c.c. $C_2Cl_4$.

In the case of No. 2 a second dose was administered by the owner on the following day. The tetrachlorethylene, No. 3 group, produced marked distress and one of the sheep died within a few minutes after having received the injection.

The rest of the flock, 150 sheep, were all given the same injection as No. 1 group of the test sheep, but their faeces were not examined. However, they also received a distinguishing mark.

On 19.5.39, i.e., 14 days after treatment, the owner prepared faeces samples from the test sheep which were still alive at that time, in the same way as had been done before treatment, and forwarded them for examination. He also wrote that a number of the treated sheep had died and he had found lungworms in all. The remaining sheep had not improved in condition.

The prepared faeces samples were examined by sucking up material from the bottom of the tube by means of a pipette and examining this under the microscope. In negative cases several such samples were examined. The findings were as follows:—

| | *Positive* 4.5.39. | *Positive* 19.5.39. |
|---|---|---|
| Group I ... ... ... ... ... ... | 12 of 13 | 3 of 8 |
| Group II ... ... ... ... ... ... | 9 of 9 | 3 of 6 |
| Group III ... ... ... ... ... ... | 2 of 2 | 0 of 1 |

The number of specimens examined is smaller than the number of sheep because a few specimens were broken in transit to the laboratory.

These results do not appear to be quite dependable, because when the second test was made on 30.6.38 eight infected sheep of Group I and four infected sheep of Group II were found.

It may be that the treatment stopped egg-production for a time while the worms were not killed.

*The second test*, 30.6.39, was made with the assistance of the Government Veterinary Officer of Ermelo, Mr. M. de Lange, who gave the second injections and finally made the post-mortem examinations. I wish to express my appreciation of his willing collaboration in this matter.

For this test 20 sheep were selected by faeces examination, as in the first test, except that the specimens were examined fresh, on the farm. Group I was injected with the mixture Iodine 1, Potassium iodide 2, Water 1,500; dose 15 c.c. Group II was injected with a proprietary concentrated pyrethrin preparation "Pyefly" 1·25 c.c., olive oil 250 c.c.; dose 10 c.c.

The first injection was given on 30.6.39 and half of the sheep of each group received a second injection 13 days later. On 1.8.39, i.e., 19 days after the second injection the sheep then still living were killed. The results are given in the following table:—

| Sheep No. | Infection 30/6/38. | Treated (Group) 30/6/38. | Treated (Group) 13/7/39. | Infection 1/8/39. |
|---|---|---|---|---|
| 2 | xxxx | I | I | xxxx |
| 4 | x | I | I | 0 |
| 7 | xxx | I | I | xx |
| 10 | xxxx | I | I | xx |
| 12 | x | I | I | xx |
| 16 | xxx | I | - | x |
| 22 | xxxx | I | – | 0 (2/7/39) |
| 23 | xx | I | — | 0 |
| 5 | xxx | I | | x (23/7/39) |
| 11 | xx | I | | x (10/7/39) |
| 1 | xx | II | II | 0 (20/7/39) |
| 14 | x | II | II | xx |
| 18 | xxx | II | II | xxx |
| 19 | xx | II | II | xxx |
| 20 | xx | II | - | 0 (2/7/39) |
| 15 | xx | II | - | x (10/7/39) |
| 21 | x | II | | xxx |
| 24 | xx | II | — | 0 |
| 30 | xx | II | | xxxx |
| 32 | x | II | | x (25/7/39) |

*Remarks. Infection* 30.6.38.—The grade of infection, estimated according to the number of larvae found on examination, was arbitrarily indicated as x to xxxx.

*Infection* 1.8.39.—The grade of infection found at post-mortem was indicated as follows:—

x: 1- 10 worms present.
xx: 10- 50 worms present.
xxx: 50-150 worms present.
xxxx: over 150 worms present.

In those cases in which a date is given after the grade of infection the sheep had died on those dates and had been examined by the owner. He merely noted whether worms were present or not and a x in such a case therefore gives no indication of the grade of infection.

The results of this test can be summarised as follows:—

| | | |
|---|---|---|
| Group I | One treatment | 3 of 5 still infected. |
| Group I | Two treatments | 4 of 5 still infected. |
| Group II | One treatment | 4 of 5 still infected. |
| Group II | Two treatments | 3 of 5 still infected. |

The results of these tests are not very promising. On the whole it would not appear as if intratracheal injections could be very effective, on account of the fact that the worms are located in the smaller bronchi, in which they lie in a mass of fairly thick mucus. Unless a very specific drug can be found and this can be injected in a vehicle which will mix with the mucus and so penetrate to the worms, this method of treatment seems bound to fail. In cases of very light infection the intratracheal injection may possibly be satisfactory, but such cases hardly need to be treated, unless this is done to prevent further infection of pastures.

## SUMMARY.

Intratracheal injections of iodine and pyrethrin mixtures against *Dictyocaulus filaria* in sheep, administered as described by Orloff, were not successful in removing the parasites. It would appear, however, as if such iodine injections may stop egg-laying for a number of days and in this way led to false conclusions.

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# *Marshallagia marshalli* (Ransom, 1907) Orloff, 1933 and a New Species of this Genus from Sheep in South Africa.

By H. O. MÖNNIG, Section of Parasitology, Onderstepoort.

In 1907 Ransom described a nematode parasite from the abomasum of sheep and named it *Ostertagia marshalli.* The same species was described in 1910 by Marotel as *O. tricuspis.* The parasite, although having many points in common with other species of *Ostertagia,* differs from them in a few important features and was therefore placed in a separate new genus *Marshallagia,* created for the purpose, by Orloff in 1933. Meanwhile, in 1932, Bhalerao described *Ostertagia orientalis* from goats in India and this species was transferred to the genus *Marshallagia* by Travassos in 1937.

*M. marshalli* has been recorded from several countries and from sheep, goat, *Rupicapra rupicapra* and *Camelus batracianus.* It is here recorded for the first time from sheep in the Union of South Africa.

In the course of a survey of the Union, made in order to determine the distribution of *Gaigeria pachyscelis,*, the eggs of *Marshallagia* were seen in a number of specimens. These eggs (Fig. 7) are conspicuous on account of their large size, in which they resemble the eggs of *Nematodirus* spp. They are, however, narrower and the ends are less pointed, while the embryo consists of a morula and not of a few cells as in the case of *Nematodirus,* when passed in the faeces of the host. For the purpose of this survey some 2,000 specimens of fresh sheep faeces were collected on farms all over the Union, placed immediately in 10 per cent. formalin and forwarded to Onderstepoort for examination. The method was quite satisfactory and such a survey is of great value. The *Marshallagia* eggs were found only in specimens from the central area of the so-called South African desert, the Karroo, that is in the Calvinia - De Aar - Beaufort West area, which has a very low rainfall. Incidentally it may be noted that *Nematodirus* eggs were similarly seen only in specimens from the Karroo, although its distribution is wider and covers the whole of this region.

*Marshallagia* eggs were subsequently found at Onderstepoort in the faeces of sheep introduced from the infected area and the worms were found at post-mortem examination. *Ostertagia* is usually found in the posterior, fundus portion of the abomasum, while the *Marshallagia* worms were always found, in the cases so far examined, to inhabit mainly the anterior portion of the abomasum, close to the entrance of the oesophageal groove.

## MARSHALLAGIA MARSHALLI (Ransom, 1907).

All the worms collected so far, with the exception of one male, belong to this species.

The worms are brown in colour and lie in the mucus covering the mucous membrane. They could be mistaken for males of *Haemonchus contortus*, although these are stouter. The head is inconspicuous and its cuticle is not inflated. The body cuticle is marked by longitudinal ridges which vary in number in different regions; at the middle of the body there are about 28 ridges in the female and 34 in the male. The oesophagus is simple, club-shaped. The cervical papillae are small, triangular.

The females are 16·5-18·5 mm. long (12-20 mm., Ransom) and 0·143-0·208 mm. wide just behind the vulvar region. The head is 0·022 mm. wide. The nerve ring is situated 0·3-0·31 mm. from the anterior extremity, the excretory pore 0·342-0·39 mm. and the cervical papillae 0·385-0·422 mm. The oesophagus is 0·858-0·897 mm. long.

The vulva is in most cases covered by a cuticular flap and is situated 3·705-4·186 mm. from the posterior end of the body (2·5-5 mm., Ransom). There is a short vagina which opens into two ovejectors, arranged according to the amphidelph type. The muscular ovejectors are 0·364-0·429 mm. long. The eggs are longate-oval, with rounded ends, containing a well-developed morula stage and measure 130-200 × 55-89$\mu$. The tail of the female measures 0·26-0·3 mm. and tapers out to end in a slight knob-like swelling; the posterior quarter shows transverse striation of the cuticle.

The *males* are 11·5-12·5 mm. long (10-13 mm., Ransom) and 0·17-0·175 mm. wide across the region of the heads of the spicules. The head of the male is 0·021 mm. wide. The nerve-ring is situated 0·3-0·35 mm. from the anterior extremity, the excretory pore 0·34-0.35 mm. and the cervical papillae 0·377-0·43 mm. The oesophagus is 0·82-0·85 mm. long.

The bursa has two large lateral and a small dorsal lobe. The latero-ventral ray is larger than the ventro-ventral and initally diverges from the latter, but distally it again bends forward so that the tips come close together. The antero-lateral stands apart from the other two lateral rays and ends in a blunt tip. The medio-lateral, postero-lateral and the externo-dorsal rays are close together and end in slender tips; the externo-dorsal ends some distance from the margin of the bursa. The postero-lateral is a slender ray throughout and is attached to the medio-lateral in a characteristic way. The dorsal ray gives off the externo-dorsal at its base; the dorsal stem is slender, 0·286-0·272 mm. long and bifurcates in less than the posterior quarter of its length; each bifurcation bears a small lateral branch behind its middle and ends in a bifurcate tip near the margin of the bursa.

As in *Ostertagia* there is a large accessory bursal membrane supported by two slender rays. Prebursal papillae are present.

The spicules are brown in colour, 0·255-0·286 mm. long. Their structure is not clearly seen unless they are dissected out, as each spicule ends in three slender tips which bear large cuticular membranes. One of these tips is slender and ends in a point, another is stouter and longer and ends in a bifid tip, the third is still stouter and ends squarely.

## MARSHALLAGIA BREVISPICULUM n.sp.

A single male was found, together with *M. marshalli*, and no females could be seen in this material, which might belong to this new species, although they would probably be very similar to those of *M. marshalli*.

The worm is brown in colour and 12 mm. long, by 0·169 mm. broad across the heads of the spicules. The head is not conspicuous and 0·021 mm. wide. The nerve-ring lies 0.325 mm. from the anterior extremity, the excretory pore 0·351 mm. and the cervical papillae 0·385 mm. The body cuticle is marked by 42 longitudinal ridges at its middle. The bursa is very similar to that of *M. marshalli*, also as regards the attachment of the postero-lateral ray. The dorsal ray is 0·25 mm. long. Prebursal papillae are present. The spicules are stout and short, 0·15 mm. long. The single specimen could not be dissected and the spicules therefore not clearly seen, but their appearance is shown in the accompanying figures (Nos. 5 and 6). There are two acute, curved tips distally and apparently also a rather blunt continuation of the main body of the spicule which is not as long as the two tips.

*Host*: *Ovis aries*.

*Location*: Abomasum.

*Locality*: De Aar.

Type in Onderstepoort Helminthological Collection.

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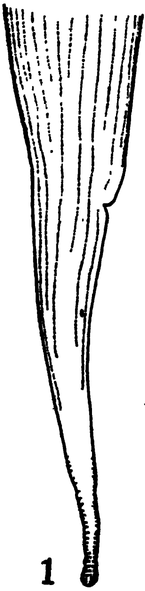

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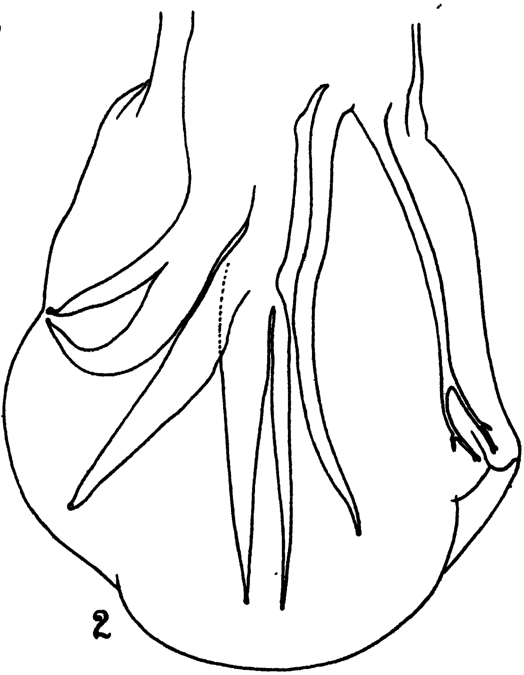

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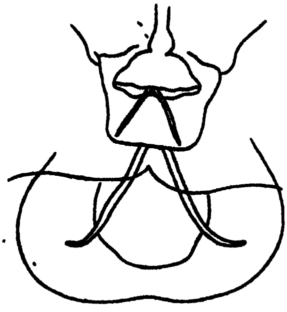

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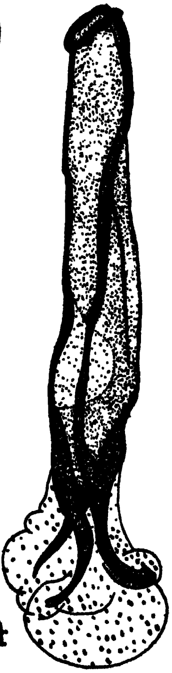


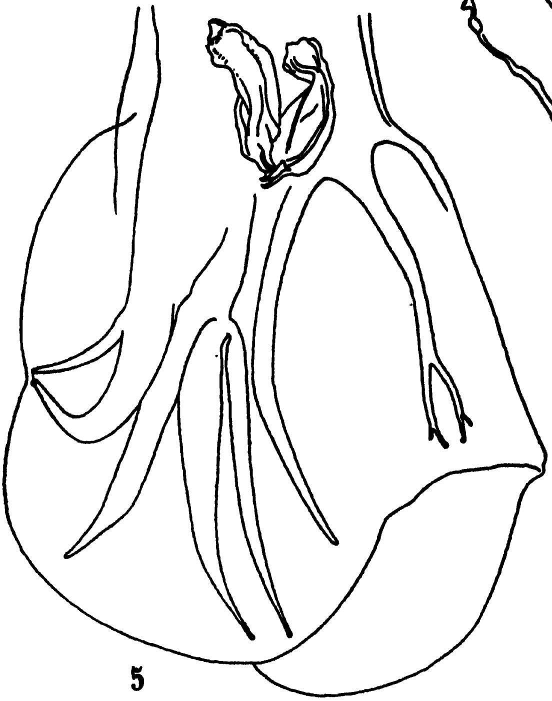
4

Fig. 1.—*M. marshalli*, tail of female.

Fig. 2.—*M. marshalli*, male bursa.

Fig. 3.—*M. marshalli*, male, accessory bursal membrane.

Fig. 4.—*M. marshalli*, male, spicule.



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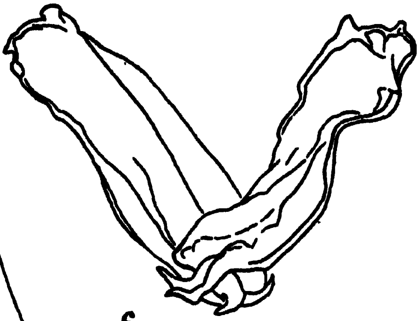

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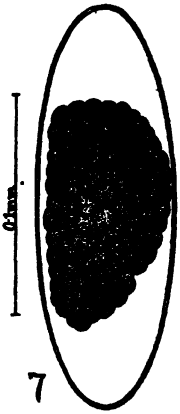

7

Fig. 5.—*M. brevispiculum*, male bursa and spicules

Fig. 6.—*M. brevispiculum*, male, spicules.

Fig. 7.—*M. marshalli*, egg, as passed in faeces of host.

# Section IV.

# Mineral Metabolism and Deficiency.

| | | |
|---|---|---|
| Du Toit, P. J., Louw, J. G., and Malan, A. I. | A study of the mineral content and feeding value of natural pastures in the Union of South Africa ... ... ... | 123 |
| Malan, A. I., du Toit, P. J., and Groenewald, J. F. | Iodine in the nutrition of sheep (Final Report.) ... .. ... ... ... ... ... ... | 329 |
| Van der Merwe, P. K. | The significance of fluorine traces in natural waters and a proposed method to effect their removal ... ... | 335 |
| Van der Merwe, P. K. | A procedure for the micro determination of fluorine ... ... ... ... ... ... ... ... | 359 |

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# A Study of the Mineral Content and Feeding Value of Natural Pastures in the Union of South Africa (Final Report).

By P. J. DU TOIT, J. G. LOUW, and A. I. MALAN,
Section of Biochemistry, Onderstepoort.

CONTENTS.

I. Introduction.
II. Plan of the Investigation and Methods.
III. Results.
  (1) General.
  (2) Phosphorus and Crude Protein.
  (3) Calcium and Magnesium.
  (4) Potassium, Sodium and Chlorine.
  (5) Crude Fibre and Soluble Ash.
  (6) Interrelationship of some constituents.
IV. General Summary and Conclusions.
V. Acknowledgment.
VI. References.
VII. Appendix.

## I. INTRODUCTION.

In the first publication (du Toit, *et al,* 1932) of the above series it was stated that the investigation was undertaken to define the phosphorus deficient areas in the Union of South Africa. The possibility of other mineral deficiencies and a study of the feeding value in general, in so far as figures for crude protein, crude fibre and carbohydrates could provide a criterion was, however, also kept in mind when the scheme was under consideration. In other words the need for more detailed data on pastures generally and their bearing on problems of nutrition and disease may be considered to have formed the basis for the series of investigations.

Originally it was decided to analyse the soil from selected areas, the herbage growing on that soil and the blood of cattle grazing on the pasturage. It was thought that a definite correlation existed between these three sets of data and that possibly the collection of data on any one of these sets of analyses would yield sufficiently accurate results to render the other two superfluous. The scheme was divided into two parts, one of which aimed at studying the effect of stage of growth on the chemical composition, yield and digestibility of indigenous grasses established on experimental plots. The results of this work have been reported by du Toit *et al* (1934, 1935) and Louw (1938). The other part of the scheme dealt with a mineral survey of the pastures of the Union. Samples of soil, vegetation and blood were collected and forwarded to Onderstepoort by about forty Government field veterinary Officers, each selecting an aera for collection in his district. The first three surveys took place in May, 1930, May, 1931, and October, 1931, respectively, after which regular collections were made during January, April, July and October of each year until April, 1933. After the first three surveys which were reported on separately by du Toit *et al* (1932) the collection of soil samples was discontinued. The results warranted the conclusion that soil analysis does not provide a satisfactory method for studying the feeding value of natural pastures as obviously pasture on poor soil may yield excellent values if the samples for analysis are taken at an early stage of growth of the pasture.

Reporting on the succeeding surveys comprising the analysis of pasture and blood samples at three-monthly intervals collected until April, 1933, du Toit and his collaborators (1935) stated that the diagnosis of phosphorus deficiency in pasture by determining the inorganic phosphorus content of the blood of animals grazing such pastures is simple and accurate, but that the surveys were intended to be a study of the feeding value of South African pastures and not merely a study of their phosphorus content and hence pasture analysis, which is essential for a study of the greater problem of the feeding value of the pastures and which incidentally includes the determination of phosphorus in the pastures already covers the field of phosphorus deficiency. Blood analysis was therefore eliminated from the subsequent surveys which were carried out on an extensive scale. Naturally blood analysis would have involved the bleeding of many hundreds of animals over extended periods, a procedure which after several repetitions was generally met with a certain amount of opposition on the part of the farmers. Another obstacle in the way of drawing the blood and preparing it for despatch to the laboratory for analysis was that sufficient professional assistance was not available to analyse and handle such a large number of samples simultaneously.

On the other hand, Government stock inspectors are stationed practically all over the Union and it was consequently decided to entrust to these stock inspectors the work of collecting and despatching of pasture samples to Onderstepoort; this procedure increased the number of samples actually collected since November, 1933, very considerably. In fact, whereas previous to this date only about forty samples were collected every three months by a limited number of field veterinary officers the stock inspectors collected and despatched to Onderstepoort every month between 200 and 250 pasture samples for analysis.

The present report deals with the results of this more comprehensive survey which covers a period of two years from November, 1933, to October, 1935.

## II. PLAN OF THE INVESTIGATION AND METHODS.

In October, 1933, some 240 stock inspectors stationed all over the Union were instructed each to collect and forward to Onderstepoort a sample of pasturage during every month of the year. For this purpose each inspector had to choose three farms in his own area and on these farms the samples had to be collected in rotation as follows: a sample of the pasture was collected on farm No. 1, in, say, November. In December, when the second sample had to be collected, it was taken from farm No. 2 and in January on farm No. 3. In February the sample was again taken on farm No. 1, in March on farm No. 2, etc. Hence, over a period of 12 months, for instance, from November, 1933, to October, 1934, the samples would be collected—

on farm No. 1 in November, February, May and August,
on farm No. 2 in December, March, June and September, and
on farm No. 3 in January, April, July and October.

According to this new scheme the number of farms on which samples of pasturage would be collected was increased from approximately 40 to almost eight hundred and the method to be followed in collecting the samples was at the same time modified.

The choice of pasturage for analysis in the new scheme was indirectly delegated to the grazing animal itself, the underlying motive being to ensure the collection of a composite sample of herbage which would as far as is practicable be representative of what the animal actually ate on the day when the sample was collected. In order to accomplish this object a number of animals had to be followed while grazing by the stock inspectors who selected the analytical sample to correspond as closely as possible to what the animals he was following actually ate. If the animal followed took a mouthful of leaves of a certain kind of grass the stock inspector would also collect a handful of leaves from the same tuft, or from one of the same kind of grass,and place this in his collection bag. If the animal then took a mouthful of seedheads the Inspector would collect a handful of seedheads from that tuft or a similar one and place it in the same bag as the first handful of leaves. If the animal then took a mouthful of bushes he also collected a handful of the same bushes into the same bag as the first two samples, and after following five or six animals and collecting about 2 lb. of vegetation in this way his sample was taken to approximate that which the animals had actually eaten very closely. The inspectors were requested when following sheep to spare no pains to collect a representative sample of what the sheep actually consumed.

In areas where the pasture was composed only of grasses or of bushes the samples collected probably approached a true representative sample of what the animal actually consumed more closely than those collected in areas where mixed samples—grass and bush—were collected as obviously it is difficult to collect these in exactly the same proportions that they are consumed by the animal.

Differences in chemical composition do exist between one species of grass and another and the aerial parts of a grass plant (leaves, haulms, etc.) also differ in regard to their mineral and protein contents but these differences are not of such a magnitude that the composition of a sample collected by only approximate simulation of the grazing animal by the collector would differ materially from that of the herbage actually consumed by the animal. Samples collected on veld composed of bushes only will for similar reasons also be highly reliable as indices of actual consumption. Since, however, as will be evident when the results are discussed later on in this report, the chemical composition of bushes and grasses may differ considerably in the case of certain constituents, the collection of a representative sample of herbage on pasture composed of bushes and grasses will decidedly confront the collector with greater difficulties, in that he has to collect a sample which must not only contain the species (grass and bush) selected by the animal but the degree of preference exhibited by the animal for either grass or bush must be reflected in the percentage of either of these veld types in his composite sample to be submitted for analysis.

On reaching the central laboratory at Onderstepoort the samples were dried, if necessary, described, freed from soil, finely ground, bottled and put away for chemical analysis. The description of the pasture samples was somewhat superficial. The following is a brief explanation of the descriptive terms employed: Samples were composed of either grasses only, bushes only, or of mixtures of grasses and bushes in varying proportions. The term " bush " was used in the case of all non-graminaceous perennial and annual plants. A sample of grasses only was described as " grass, green "; " grass, mainly green "; " grass "; " grass, mainly brown "; and " grass, brown ". The terms " green " and " brown " are self-explanatory. The term " grass " indicates that it was judged that the sample was composed of roughly equal amounts of green and brown grass, respectively, whereas a sample was described as " mainly green " or " mainly brown " depending on the estimated amounts of green and brown grass in the composite sample. In addition, certain outstanding features in a grass sample were described. Thus, a sample was " leafy " when it was almost entirely composed of leaves only, few stalks being present; or " long " when the sample forwarded was made up of the aerial parts as a whole of grass tufts 12 inches or more in length. Also, the grass in a sample was described as " short " when the effective growth on the tufts was not more than about 2-3 inches in height either due to overgrazing or very little new growth at the commencement of the rainy season. The advancing stages of maturity in the case of bushes were not described, since, on the one hand, the bush samples received were in the majority of cases " green " and, on the other hand, the description for a mixed sample of bushes and grasses would have been too long and cumbersome. The term "bush", then, meant that the sample was composed of bushes only; describing a sample as "grass and bush" signified a composite sample of the two veld types in which the amounts of bush and grass were more or less in the ratio of 1:1. A preponderance of one or the other veld type in the composite sample was indicated by adding the words "mostly bush" or "mostly grass", as the case may be, to the description given above. To illustrate, the description: "Grass, mainly green, leafy, and bush; mostly grass" would mean that, in the first place, there was proportionately more grass than bush in the composite sample and, in the second place, the grass moiety of the sample consisted almost exclusively of leaves, the majority of which were still in a green state.

The description of a sample was included with the scheme in order to give a rough indication of the stage of growth of the plants composing the pasture sample so that the influence of stage of growth on the chemical composition may be judged in the case of every sample collected. However, these descriptions as indices of stage of growth must be looked upon as only approximate; a "green" sample might for instance be composed of herbage at a stage of growth ranging from anything between two weeks and two months: i.e. at any stage from tillering to post-flowering or seeding.

As stated previously some 240 stock inspectors were entrusted with the task of collecting pasture samples and the actual work had to start in November, 1933. This meant that over 700 farms were involved, although this number oscillated considerably during the course of the investigation. The majority of officers responded immediately by forwarding their first samples during November while a few collected their first samples only in December or even January and February of 1934.

It was originally intended to continue the collection of samples for at least three years but it was soon realised that owing to the large amount of analytical work involved the available chemical staff would be unable to complete all the analyses in a reasonable length of time. For this reason it was decided to cover a period of two years only and the collection of samples which, as stated previously, was started in November, 1933, was discontinued in October, 1935.

It may, finally, be stated that the instructions in regard to the method of rotating the collection of samples on three chosen farms were strictly adhered to by officers in only about 50 per cent. of the cases. For good reasons many officers had to replace one or more of their original farms with different ones, or the date on which a collection had to be made on a certain farm had to be altered. This, however, is not considered a serious defect in the scheme since the object is not so much to determine the feeding value of the pasture on certain farms but to get an average quality index of pastures in different areas or districts of the Union at different times of the year.

All chemical analyses are given on a dry matter basis and the methods employed were the same as those described by Louw (1938). Altogether close on 5,000 samples were analysed.

## III. RESULTS.

### (1) GENERAL.

Tables giving the analysis on the basis of the dry matter together with a description of each individual pasture sample received are presented in an appendix to this report. Owing to the mass of data collected it is impossible to consider each farm or locaility by itself. It has consequently been decided to divide the country into eighteen different areas (see Chart I) and to construct tables giving the average composition of all the samples collected in each area and during each month of the year separately. The principal districts comprising an area are given in a legend to Chart I. No samples were collected in areas (e.g. Basutoland) not marked on the chart, while the analyses of the limited number of samples which arrived from the strip of country stretching from Piquetberg on the west coast along the south coast to Humansdorp, marked " O ", are given in the appendix only; the calculation of averages from the available data for this region was not considered justifiable.

The division of the country into eighteen areas was made mainly on the basis of the Botanical Map of the Union of South Africa (Pole-Evans, 1936). Although, to a certain extent, rainfa was also taken into account, the division into areas remains somewhat arbitrary.

It was thought that more reliable values would be obtained for the composition of the pasture if the analyses of the separate years were not considered separately. Consequently, the analyses of all the samples collected during any one month, irrespective of the year, in, say, area 1 were grouped together and average values for each constituent calculated for that particular month. In this way average values for each constituent determined and for each of the twelve months, January to December, were calculated in the case of every one of the 18 areas into which the Union was divided. These average values for an " average " year though not, as may be expected, applicable to the pasture on each of the farms situated in that area separately may, nevertheless, be taken to provide a fair criterion for judging the feeding value of the pastures in the area as a whole, particularly with reference to the changes in the feeding value of the pastures from January to December.

The rainfall data for the two years from November, 1933, have been treated in a manner similar to that outlined above for the chemical analyses of pasture samples in order to arrive at average monthly rainfall figures for an " average " year in the case of each of the 18 areas in question. Briefly, it means that, for instance, the mean rainfall for January in area 1 was obtained by averaging all the available rainfall data registered on farms in area 1, from which samples were actually forwarded, during January, irrespective of the year. Unfortunately, not all the farms where the pastures were sampled were provided with rain guages, so that in many cases the rainfall data of the towns or villages nearest to such farms had to be

utilised in order to make the average figure as representative as possible of the area as a whole. The average monthly rainfall figures calculated as indicated are given in Table 1 in inches.

Judging from the averages for different areas given in a publication by Schumann and Thompson (1934) on certain aspects of rainfall in South Africa, and from the Reports of the Union Meteorological Office for the years 1934 and 1935, the former being on the whole above and the latter year below normal in regard to rainfall the "average" year arrived at from the data of the two years covering this investigation seems to be a fair indication of normal conditions.

A study of the descriptions of individual samples given in the appendix reveals the following: 93-99 per cent. of the samples originating from areas 1-4, from areas 6-8, and from area 11 were composed of grasses only, the rest being "bush". Grasses were predominant in mixed samples from areas 5, 9, 10, 12 and 13, the percentages of samples composed of bush only being 12·0, 10·0, 17·0, 26·0 and 34·0, respectively. On the other hand, the samples from Area 17 were made up almost exclusively of bushes; bushes predominated in the samples forwarded from Areas 15 and 16, only about 20 per cent. being composed of grass, whilst in the remaining two areas, numbers 14 and 18, the numbers of grass and bush samples, respectively, were approximately the same. The percentages of grass and bush samples cited above do not, of course, and are not intended to, reflect actual conditions in the veld with mathematical precision, but judging from a knowledge of veld conditions in some of the areas and the botanical map previously referred to, the proportions of grass and bush samples in the total numbers forwarded from the various areas, and reflected in these percentages, may be taken to be a fair approximation in the case of most areas.

The average monthly chemical composition and the range of variation in the composition of individual samples are given in Tables 2 and 3 and tables 8 to 14 for each of the 18 areas into which the country has been divided. Reference should be made to table 2 for a record of the numbers of samples analysed for each month, and for an approximate description of the type of veld in an area as a whole. The range values, giving minimum and maximum figures for each month, were included to indicate the wide differences that may occur in the composition of samples collected during the same month in any one area.

Naturally, considerable variation is expected in samples secured over an extensive region of natural veld—the areas in question measure 8,000 square miles and more—if the factors influencing the chemical composition of such pastures are kept in mind. In this connection reference needs only to be made to the fact that most of the rain in the greater part of this country falls in the form of intermittent showers resulting often in considerable variation in the precipitation on two adjacent farms, let alone on farms 50 or more miles apart in the same area. Although the influence of soil fertility and botanical composition of the pasture is by no means negligible the main factor responsible for the wide differences in the chemical composition of pasture samples from the same area is no doubt the variable rainfall which in turn is responsible for pasturage at various stages of maturity. The existence of the great variation in the mineral and protein contents of the pasture samples collected during the same month inevitably impairs the significance of the average values somewhat. At the same time the average values which will form the basis of the following discussion may be taken to describe even if it is only in a rough way, the quality of the pasturage of a specific area as a whole more closely than would any of the individual values within the range of variation observed. In particular the average values afford a valuable picture of the seasonal tendency in the chemical composition of the pasturage.

## (2) Phosphorus and Crude Protein.

The average values for phosphorus and crude protein given in tables 2 and 3 for the 18 areas separately are presented in graphical form in Figs. 1 to 5. The outstanding feature in these graphs is the gradual downward tendency from January to July or August followed by a rise of varying intensity to November or December for both P and protein in the case of all the grassland areas of the Union. This downward and upward curve is closely correlated with the rainfall in the areas concerned as will be evident from a glance at table 1. On the other hand the graphs describing the monthly averages for mixed (grass and bush) veld do not show a definite tendency from January to December.

The irregular fluctuations may probably be mainly ascribed to varying proportions of bushes and grasses in the mixed samples collected from month to month and to the fact that bushes are more resistant to drought and retain their nutritive properties longer than do grasses, as is evident from the higher level in the average values for both phosphorus and protein in samples containing a high percentage of bush throughout the year. The mineral composition and protein content of bushes are influenced, though not to the same extent as are grasses, by rainfall as is evident from a study of the monthly average values and rainfall for Area 17, a winter rainfall area, and the only one in which the samples collected were practically all composed of bushes only. Unlike all other areas maximum values for P and protein were here obtained during the winter months.

An examination of the phosphorus and crude protein figures shows that at no time can the pastures of the Union be considered to be rich in these constituents as judged by oversea standards. In the summer rainfall grassland areas the phosphorus and protein values reach their highest levels in November, December or January, 0·12 to 0·17 per cent. and 7·0 to 9·0 per cent, respectively. From January there is a gradual decline to the extremely low values of 0·05 to 0·07 and 3·3 to 4·0 per cent. for phosphorus and protein, respectively, in July or August followed by a gradual rise to the higher values referred to above.

Except for Areas 17 and 18, the averages for samples from areas where a high percentage of bushes were present in the samples or where bushes were predominant show not only higher maxima but the minimum values also are higher than those of the grassland areas. Figures for phosphorus never go below 0·11 per cent. in the

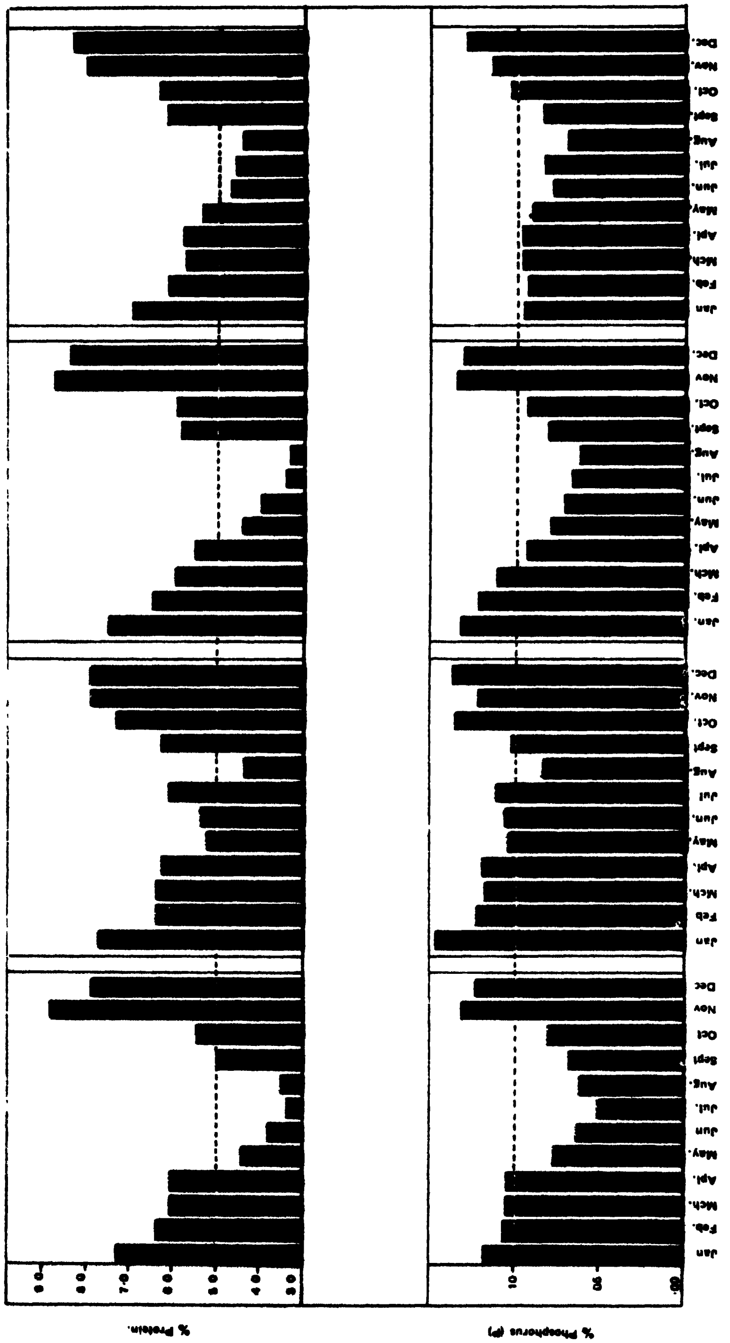


Fig. 1.—Showing the seasonal variation in the phosphorus and crude protein contents of the natural pastures of areas 1, 2, 3 and 4.

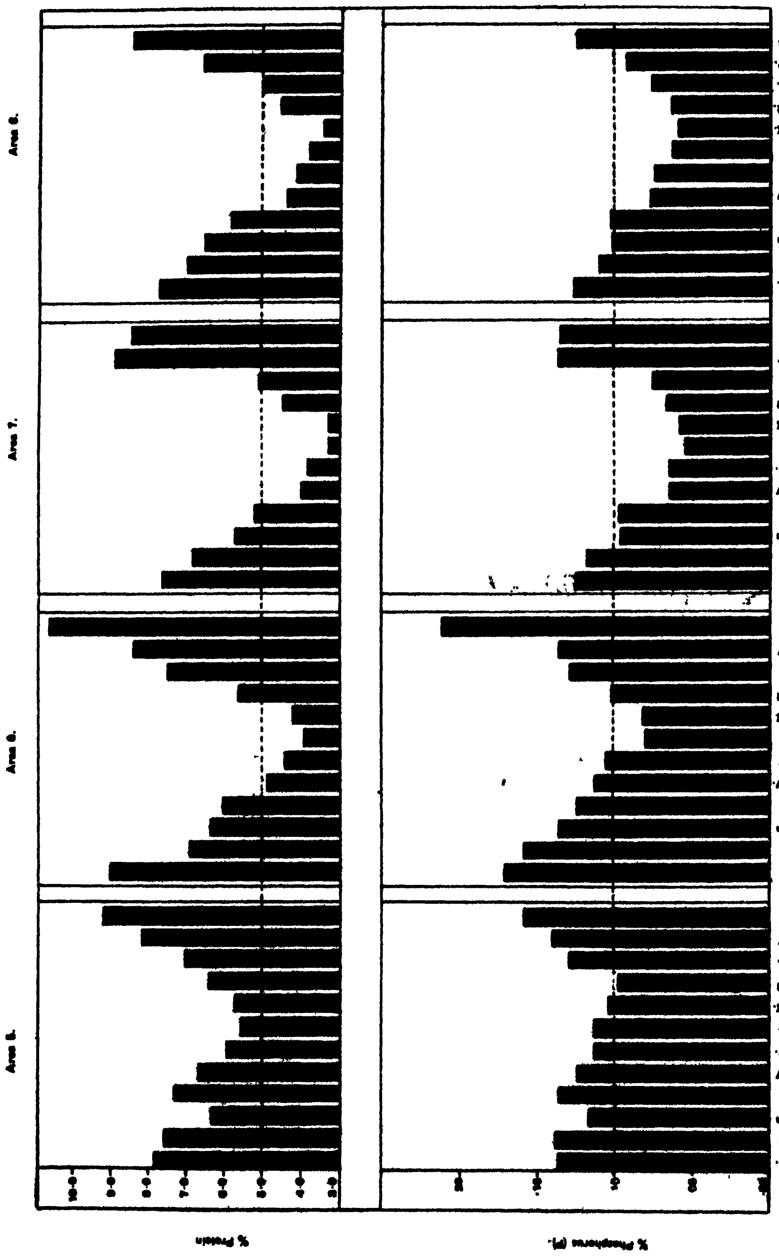


Fig. 2.—Showing the seasonal variations in the phosphorus and crude protein contents of the natural pastures of areas 5, 6, 7 and 8.

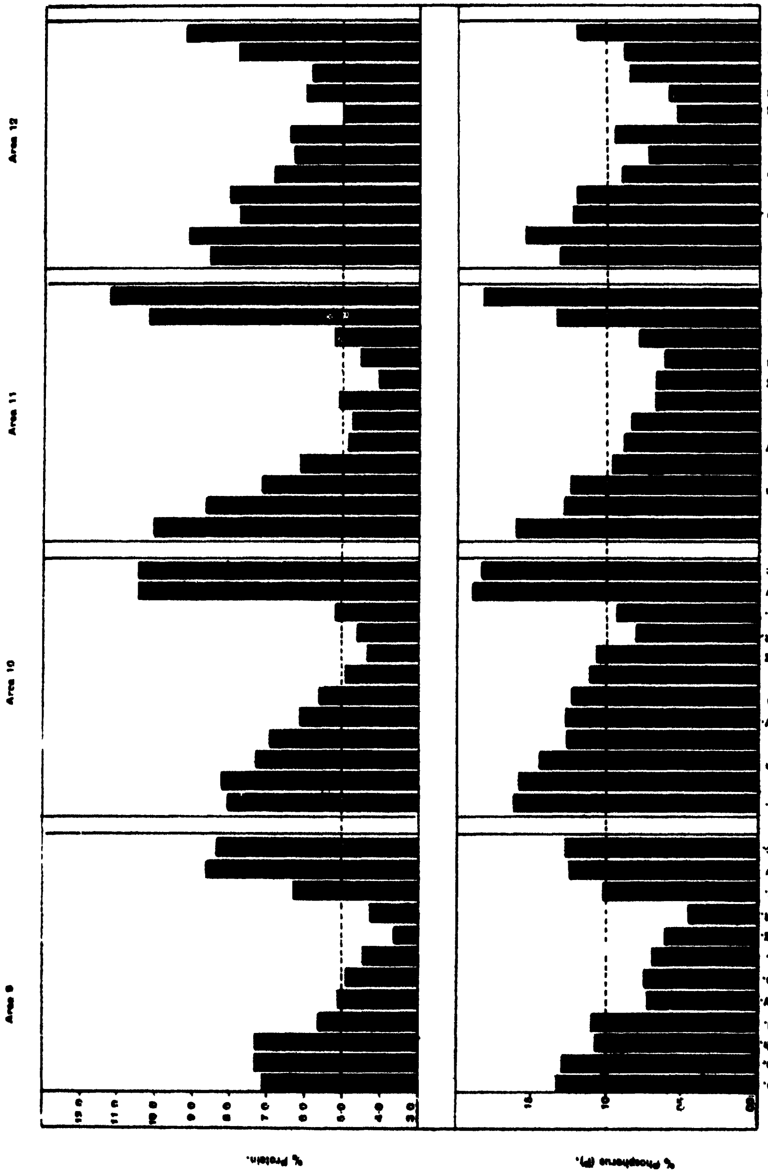


Fig. 3.—Showing the seasonal variations in the phosphorus and crude protein contents of the natural pastures of areas 9, 10, 11 and 12.

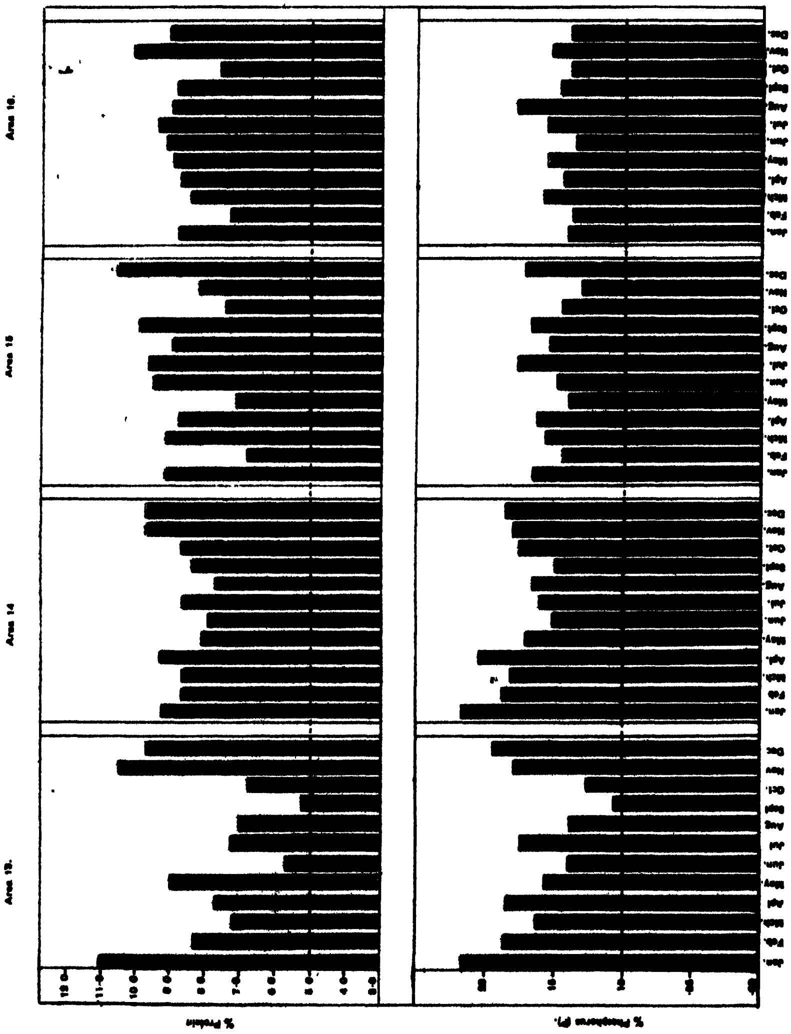


Fig. 4.—Showing the seasonal variations in the phosphorus and crude protein contents of the natural pastures of areas 13, 14, 15 and 16.

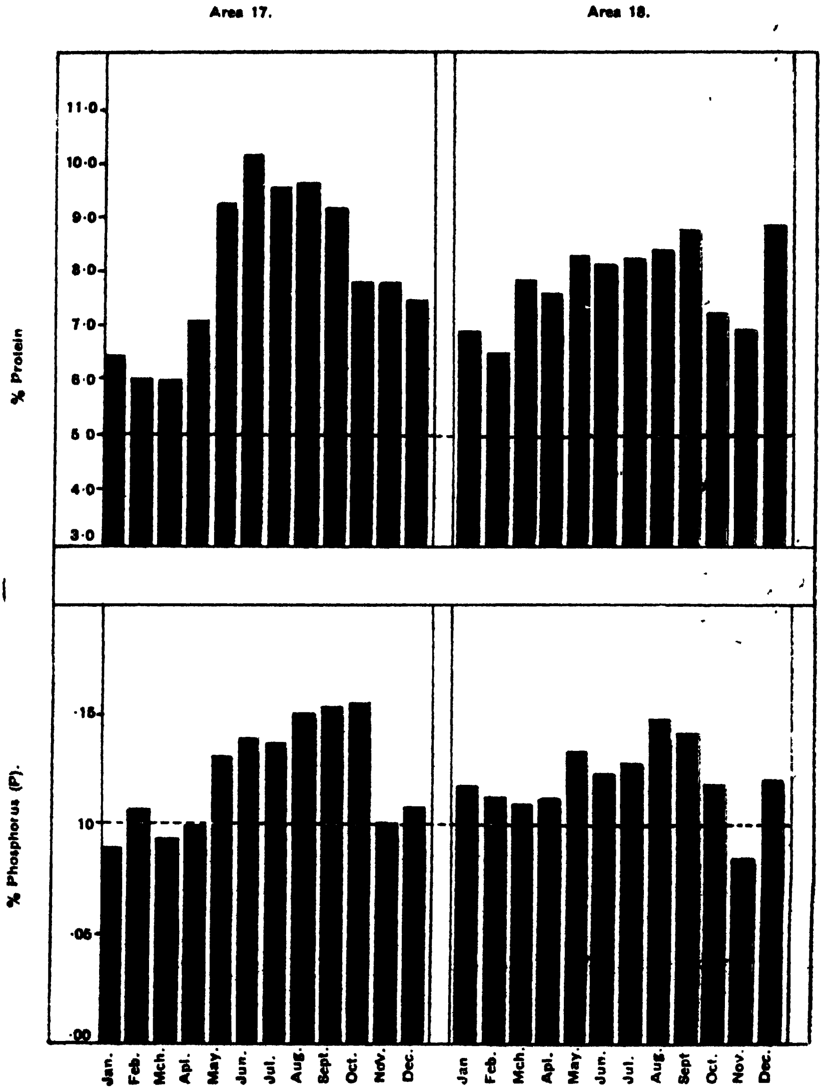


Fig. 5.—Showing the seasonal variations in the phosphorus and crude protein contents of the natural pastures of areas 17 and 18.

## TABLE 1.

### AVERAGE MONTHLY RAINFALL FOR PERIOD OCTOBER, 1933, TO SEPTEMBER, 1935, IN INCHES.

| Area. | Jan. | Feb. | March. | April. | May. | June. | July. | August. | Sept. | Oct. | Nov. | Dec. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.................... | 6·12 | 3·80 | 3·42 | 1·81 | 1·14 | 0·40 | 0·74 | 1·07 | 0·56 | 2·12 | 6·44 | 6·36 | 33·98 |
| 2.................... | 5·93 | 3·90 | 4·14 | 2·64 | 2·40 | 2·67 | 0·95 | 1·38 | 0·70 | 1·91 | 5·66 | 7·30 | 39·58 |
| 3.................... | 6·08 | 3·76 | 3·89 | 2·56 | 1·33 | 1·35 | 0·66 | 0·83 | 0·58 | 2·01 | 6·40 | 6·84 | 36·29 |
| 4.................... | 5·00 | 2·54 | 4·45 | 3·20 | 2·49 | 1·99 | 1·42 | 1·57 | 0·83 | 2·23 | 5·48 | 5·76 | 36·96 |
| 5.................... | 3·43 | 2·88 | 4·18 | 2·43 | 3·61 | 0·98 | 1·34 | 1·05 | 0·86 | 1·95 | 4·15 | 2·89 | 29·75 |
| 6.................... | 5·08 | 2·78 | 4·37 | 2·11 | 1·81 | 0·31 | 0·75 | 1·12 | 0·34 | 2·41 | 5·95 | 5·30 | 32·33 |
| 7.................... | 5·46 | 3·32 | 2·97 | 1·18 | 0·71 | 0·39 | 0·50 | 0·61 | 0·49 | 2·12 | 6·30 | 5·92 | 29·97 |
| 8.................... | 4·11 | 2·95 | 3·34 | 1·93 | 1·45 | 0·16 | 0·32 | 0·30 | 0·25 | 1·72 | 5·97 | 3·78 | 26·28 |
| 9.................... | 6·02 | 3·52 | 2·91 | 1·44 | 0·64 | 0·61 | 0·29 | 0·25 | 0·67 | 1·45 | 6·19 | 5·54 | 29·53 |
| 10.................... | 5·42 | 3·33 | 2·69 | 1·13 | 0·39 | 0·25 | 0·05 | 0·13 | 0·48 | 1·26 | 6·66 | 4·02 | 25·81 |
| 11.................... | 3·75 | 3·17 | 2·37 | 0·59 | 0·50 | 0·11 | 0·08 | 0·24 | 0·47 | 1·09 | 5·55 | 4·06 | 21·98 |
| 12.................... | 3·02 | 3·41 | 2·96 | 1·87 | 1·26 | 0·17 | 0·03 | 0·03 | 0·07 | 0·99 | 3·13 | 2·75 | 19·69 |
| 13.................... | 3·04 | 2·32 | 3·23 | 1·69 | 1·58 | 0·29 | 0·12 | 0·43 | 0·20 | 1·73 | 2·90 | 3·23 | 20·76 |
| 14.................... | 2·39 | 1·88 | 2·59 | 1·32 | 1·80 | 0·25 | 0·40 | 0·26 | 0·22 | 0·98 | 2·68 | 2·14 | 16·90 |
| 15.................... | 1·46 | 1·72 | 2·06 | 1·26 | 2·15 | 0·41 | 0·82 | 0·43 | 0·57 | 0·96 | 2·05 | 1·75 | 15·64 |
| 16.................... | 0·13 | 1·66 | 1·27 | 1·45 | 2·25 | 0·61 | 0·20 | 0·42 | 0·34 | 0·80 | 3·04 | 1·06 | 13·23 |
| 17.................... | 0·00 | 0·40 | 0·09 | 1·12 | 1·44 | 0·77 | 0·88 | 1·13 | 0·70 | 0·36 | 1·53 | 0·21 | 8·63 |
| 18.................... | 0·18 | 0·62 | 0·33 | 1·28 | 1·11 | 0·21 | 0·25 | 0·17 | 0·08 | 0·09 | 2·02 | 0·37 | 6·71 |

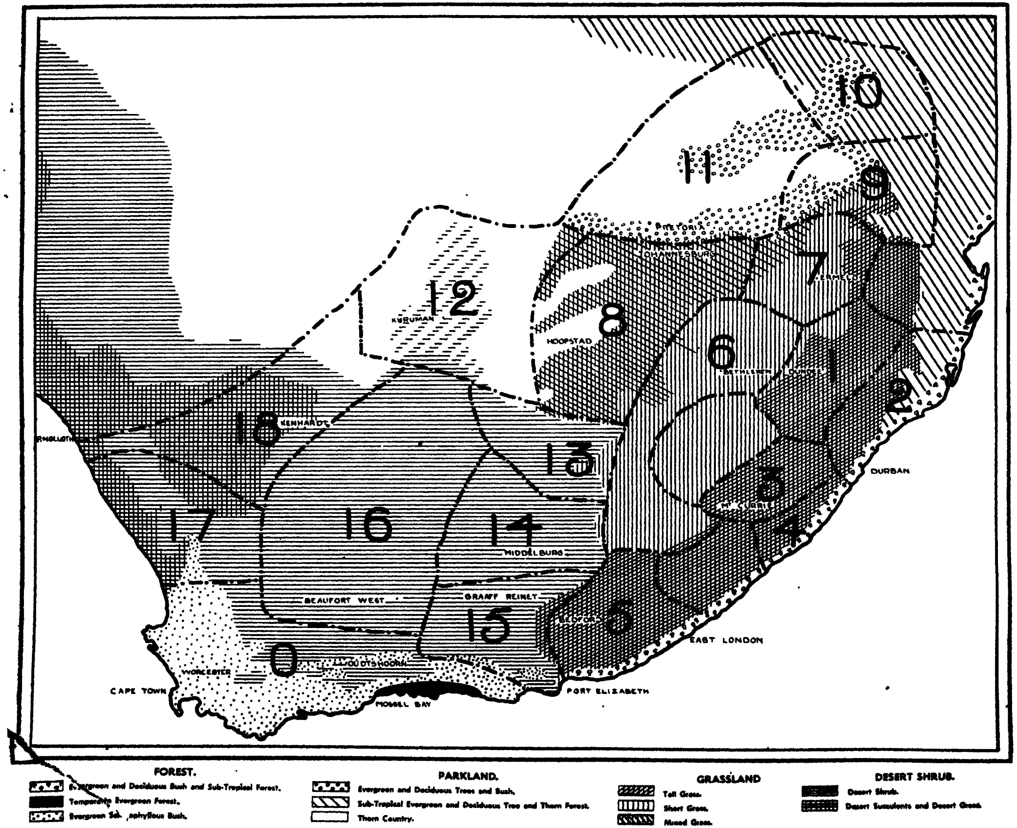
## TABLE 2.

*Mean Phosphorus (P) Content of Pastures (Numbers of Samples analysed and Range Values included).*

| Area and Type of Veld. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 (Grass) | 41 | 46 | 47 | 52 | 50 | 49 | 52 | 34 | 42 | 44 | 38 | 38 | Number of samples. |
| | **·118** | **·106** | **·105** | **·105** | **·079** | **·065** | **·053** | **·062** | **·069** | **·082** | **·133** | **·123** | **Mean.** |
| | ·064–·21 | ·055–·18 | ·06 –·21 | ·052–·31 | ·032–·16 | ·016–·12 | ·016–·11 | ·027–·15 | ·029–·15 | ·031–·21 | ·061–·26 | ·052–·32 | Range. |
| 2 (Grass) | 41 | 40 | 40 | 39 | 42 | 36 | 35 | 38 | 33 | 39 | 38 | 34 | Number of samples. |
| | **·147** | **·123** | **·118** | **·120** | **·104** | **·105** | **·111** | **·084** | **·103** | **·136** | **·123** | **·138** | **Mean.** |
| | ·057–·36 | ·058–·25 | ·044–·32 | ·039–·31 | ·03 –·26 | ·035–·29 | ·038–·31 | ·027–·22 | ·033–·21 | ·037–·30 | ·057–·24 | ·064–·26 | Range. |
| 3 (Grass) | 29 | 31 | 34 | 32 | 30 | 30 | 26 | 33 | 26 | 25 | 31 | 28 | Number of samples. |
| | **·132** | **·121** | **·111** | **·094** | **·080** | **·070** | **·066** | **·062** | **·079** | **·094** | **·131** | **·131** | **Mean.** |
| | ·065–·28 | ·06 –·20 | ·07 –·23 | ·052–·17 | ·043–·14 | ·033–·13 | ·032–·19 | ·025–·12 | ·047–·19 | ·04 –·25 | ·05 –·22 | ·07 –·22 | Range. |
| 4 (Grass) | 15 | 15 | 21 | 21 | 25 | 25 | 19 | 20 | 19 | 19 | 17 | 11 | Number of samples. |
| | **·095** | **·092** | **·096** | **·096** | **·090** | **·078** | **·083** | **·069** | **·084** | **·103** | **·115** | **·128** | **Mean.** |
| | ·053–·14 | ·05 –·19 | ·052–·22 | ·055–·23 | ·049–·19 | ·03 –·17 | ·044–·22 | ·036–·18 | ·035–·21 | ·05 –·28 | ·053–·23 | ·083–·23 | Range. |
| 5 (Mainly Grass) | 29 | 32 | 35 | 36 | 30 | 38 | 33 | 33 | 29 | 31 | 33 | 28 | Number of samples. |
| | **·136** | **·137** | **·117** | **·135** | **·124** | **·113** | **·113** | **·104** | **·097** | **·130** | **·140** | **·158** | **Mean.** |
| | ·068–·26 | ·06 –·24 | ·044–·24 | ·058–·26 | ·064–·30 | ·034–·26 | ·044–·32 | ·042–·21 | ·035–·21 | ·054–·39 | ·052–·32 | ·06 –·35 | Range. |
| 6 (Grass) | 28 | 29 | 25 | 29 | 29 | 24 | 22 | 23 | 23 | 25 | 21 | 22 | Number of samples. |
| | **·173** | **·158** | **·138** | **·125** | **·113** | **·106** | **·082** | **·084** | **·101** | **·129** | **·137** | **·212** | **Mean.** |
| | ·096–·31 | ·064–·31 | ·066–·24 | ·066–·22 | ·036–·21 | ·042–·23 | ·025–·18 | ·044–·17 | ·053–·19 | ·047–·21 | ·066–·25 | ·077–·45 | Range. |
| 7 (Grass) | 33 | 32 | 34 | 35 | 33 | 33 | 31 | 32 | 32 | 31 | 31 | 34 | Number of samples. |
| | **·126** | **·119** | **·095** | **·096** | **·065** | **·065** | **·055** | **·058** | **·068** | **·075** | **·138** | **·138** | **Mean.** |
| | ·084–·25 | ·066–·32 | ·048–·15 | ·032–·24 | ·025–·12 | ·025–·12 | ·029–·12 | ·024–·11 | ·028–·19 | ·033–·17 | ·062–·24 | ·092–22· | Range. |
| 8 (Grass) | 24 | 26 | 27 | 25 | 26 | 27 | 23 | 24 | 23 | 22 | 17 | 21 | Number of samples. |
| | **·127** | **·112** | **·101** | **·102** | **·079** | **·075** | **·064** | **·060** | **·063** | **·076** | **·093** | **·127** | **Mean.** |
| | ·054–·23 | ·065–·19 | ·056–·17 | ·050–·15 | ·029–·17 | ·04 –·14 | ·029–·11 | ·031–·098 | ·025–·15 | ·045–·13 | ·042–·16 | ·065–·22 | Range. |
| 9 (Mainly Grass) | 20 | 24 | 21 | 22 | 22 | 22 | 22 | 20 | 21 | 20 | 23 | 25 | Number of samples. |
| | **·132** | **·128** | **·106** | **·109** | **·072** | **·075** | **·069** | **·061** | **·045** | **·101** | **·124** | **·126** | **Mean.** |
| | ·058–·27 | ·064–·32 | ·052–·19 | ·043–·25 | ·03 –·15 | ·033–·16 | ·036–·17 | ·021–·093 | ·028–·09 | ·032–·24 | ·056–·26 | ·059–·26 | Range. |
| 10 (Mainly Grass) | 40 | 41 | 39 | 43 | 36 | 29 | 31 | 31 | 32 | 34 | 40 | 37 | Number of samples. |
| | **·161** | **·157** | **·144** | **·126** | **·126** | **·122** | **·111** | **·106** | **·080** | **·093** | **·189** | **·183** | **Mean.** |
| | ·039–·30 | ·068–·31 | ·071–·26 | ·044–·36 | ·061–·32 | ·031–·27 | ·041–·23 | ·046–·23 | ·043–·22 | ·035–·21 | ·044–·51 | ·078–·32 | Range. |
| 11 (Grass) | 16 | 27 | 33 | 31 | 32 | 29 | 27 | 30 | 28 | 19 | 27 | 18 | Number of samples. |
| | **·160** | **·128** | **·124** | **·096** | **·088** | **·085** | **·066** | **·066** | **·061** | **·078** | **·133** | **·182** | **Mean.** |
| | ·07 –·29 | ·074–·27 | ·062–·28 | ·057–·20 | ·041–·19 | ·028–·21 | ·035–·16 | ·025–·22 | ·025–·13 | ·038–·26 | ·056–·38 | ·07 –·33 | Range. |
| 12 (Mainly Grass) | 11 | 11 | 16 | 14 | 10 | 15 | 14 | 14 | 10 | 14 | 9 | 7 | Number of samples. |
| | **·131** | **·153** | **·123** | **·120** | **·088** | **·071** | **·095** | **·053** | **·059** | **·086** | **·089** | **·120** | **Mean.** |
| | ·07 –·35 | ·087–·22 | ·07 –·25 | ·074–·19 | ·054–·17 | ·038–·14 | ·038–·23 | ·026–·10 | ·028–·077 | ·045–·17 | ·042–·16 | ·043–·18 | Range. |
| 13 (Grass and bush) | 7 | 8 | 9 | 8 | 9 | 7 | 8 | 8 | 8 | 8 | 4 | 6 | Number of samples. |
| | **·216** | **·186** | **·164** | **·185** | **·157** | **·140** | **·175** | **·138** | **·105** | **·126** | **·180** | **·195** | **Mean.** |
| | ·10 –·30 | ·15 –·28 | ·095–·26 | ·087–·23 | ·083–·27 | ·07 –·25 | ·14 –·21 | ·082–·24 | ·074–·14 | ·063–·18 | ·12 –·32 | ·16 –·26 | Range. |
| 14 (Grass and bush) | 12 | 12 | 15 | 17 | 13 | 14 | 13 | 12 | 15 | 14 | 10 | 9 | Number of samples. |
| | **·218** | **·188** | **·183** | **·206** | **·171** | **·151** | **·163** | **·167** | **·150** | **·177** | **·180** | **·187** | **Mean.** |
| | ·12 –·44 | ·15 –·25 | ·11 –·30 | ·11 –·31 | ·08 –·36 | ·10 –·20 | ·11– ·23 | ·14 –·20 | ·09 –·25 | ·12 –·26 | ·12 –·26 | ·14– 26· | Range. |
| 15 (Mainly bush) | 12 | 11 | 14 | 14 | 12 | 14 | 13 | 13 | 16 | 11 | 13 | 12 | Number of samples. |
| | **·167** | **·147** | **·158** | **·184** | **·142** | **·150** | **·179** | **·156** | **·168** | **·146** | **·132** | **·176** | **Mean.** |
| | ·08 –·38 | ·04 –·27 | ·093–·27 | ·09– ·25 | ·033–·25 | ·07– ·26 | ·12– ·32 | ·12 –·30 | ·056–·30 | ·068–·23 | ·066–·22 | ·13 –·26 | Range. |
| 16 (Mainly bush) | 15 | 17 | 19 | 21 | 18 | 19 | 13 | 11 | 20 | 17 | 16 | 14 | Number of samples. |
| | **·143** | **·140** | **·162** | **·145** | **·158** | **·136** | **·158** | **·180** | **·148** | **·140** | **·155** | **·139** | **Mean.** |
| | ·08 –·22 | ·094–·23 | ·11 –·31 | ·084–·19 | ·048–·29 | ·077–·22 | ·073–·23 | ·06– ·32 | ·05 –·29 | ·076–·22 | ·067–·25 | ·05– ·21 | Range. |
| 17 (Bush) | 10 | 8 | 10 | 9 | 8 | 10 | 7 | 8 | 9 | 10 | 13 | 9 | Number of samples. |
| | **·087** | **·106** | **·092** | **·098** | **·130** | **·140** | **·136** | **·149** | **·152** | **·153** | **·100** | **·108** | **Mean.** |
| | ·05 –·13 | ·057–·21 | ·046–·17 | ·05 –·14 | ·083–·26 | ·094–·20 | ·11 –·16 | ·095–·18 | ·086–·21 | ·087–·33 | ·057–·13 | ·072–·15 | Range. |
| 18 (Grass and bush) | 11 | 10 | 11 | 11 | 11 | 9 | 11 | 9 | 10 | 10 | 11 | 11 | Number of samples. |
| | **·117** | **·112** | **·108** | **·111** | **·133** | **·121** | **·127** | **·147** | **·142** | **·116** | **·084** | **·120** | **Mean.** |
| | ·027–·27 | ·078–·14 | ·073–·16 | ·053–·16 | ·075–·19 | ·07 –·16 | ·097–·16 | ·078–·24 | ·10 –·24 | ·06 –·15 | ·06 –·15 | ·064–·20 | Range. |

## CHART I.

### Vegetation Map of South Africa showing Division into Areas for the purpose of discussing the Mineral Content and Feeding Value of the Natural Pastures.



## Legend to Chart I.

| *Area.* | *Principal Districts.* |
|---|---|
| 1. | Piet Retief, Utrecht, Newcastle, Vryheid, Dundee, Klip River, Helpmekaar, Weenen, Bergville, Estcourt, Lions River. |
| 2. | Ubombo, Nongoma, Hlabisa, Lower Umfolosi, Nkandhla, Eshowe, Mtunzini, Kranskop, Umvoti, New Hanover, Lower Tugela, Inanda, Camperdown, Pinetown. |
| 3. | Pietermaritzburg, Richmond, Himeville, Ixopo, Umzimkulu, Mt. Currie, Matatiele, Mt. Fletcher, Mt. Frere, Mt. Ayliff. |
| 4. | Umzinto, Alfred, Port Shepstone, Bizana, Tabankulu, Flagstaff, Lusikisiki, Port St Johns. |
| 5. | Glen Grey, Queenstown, Cathcart, Stutterheim, Komgha, East London, Kingwilliamstown, Bedford, Somerset East, Albany, Bathurst. |
| 6. | Wodehouse, Maclear, Barkly East, Herschel, Wepener, Zastron, Smithfield, Ladybrand, Bethlehem, Harrismith, Vrede, Frankfort. |
| 7. | Standerton, Wakkerstroom, Bethal, Ermelo, Carolina, Belfast. |
| 8. | Krugersdorp, Ventersdorp, Potchefstroom, Vereniging, Heidelberg, Klerksdorp, Wolmaransstad, Schweizer-Reneke, Christiana, Hoopstad, Kroonstad, Brandfort, Winburg, Bloemfontein. |
| 9. | Middelburg, Lydenburg, Pilgrimsrest, Nelspruit, Barberton. |
| 10. | Letaba, Zoutpansberg. |
| 11. | Pietersburg, Potgietersrust, Waterberg, Rustenburg, Marico, Brits, Pretoria, Witbank. |
| 12. | Mafeking, Vryburg, Kuruman, Taungs, Barkly West. |
| 13. | Herbert, Jacobsdal, Fauresmith, Dewetsdorp, Trompsburg, Philippolis, Bethulie. |
| 14. | Philipstown, De Aar, Hanover, Colesberg, Venterstad, Albert, Molteno, Middelburg, Richmond, Murraysburg. |
| 15. | Tarka, Cradock, Graaff-Reinet, Pearston, Aberdeen, Willowmore, Jansenville, Steytlerville, Uitenhage, Port Elizabeth. |
| 16. | Beaufort West, Sutherland, Fraserburg, Victoria West, Carnarvon, Williston, Britstown, Prieska, Hopetown, Hay. |
| 17. | Van Rhynsdorp, Calvinia (partly), Namaqualand (partly). |
| 18. | Gordonia, Kenhardt, Namaqualand (partly). |

course of the year while values of between 0·14 and 0·20 per cent. are the rule rather than the exception. Similarly crude protein figures seldom fall below 7·0 per cent., most values fluctuating between 7·0 and 10·0 per cent. Phosphorus values for Areas 17 and 18 are somewhat lower than and protein values on the whole of a similar magnitude as those for the other " bush veld " areas.

The differences in regard to phosphorus and protein contents of the pastures in the 18 different areas are most pronounced between those areas classified as " grass land " and those in which bushes predominate in the pastures. Whereas in the lastmentioned areas the phosphorus content of the pastures fluctuates between about 0·12 and 0·20 per cent. and the protein between 7·0 and 10·0 per cent. in the course of the year, the percentage of these constituents in samples composed of grasses only fall from peak values around 0·14 per cent. phosphorus and 8·0 per cent. crude protein during summer to as low as 0·05 per cent. and 3.3 per cent, respectively, in the dry winter months, corresponding with a change from green and succulent to dry and brown pasturage. Furthermore, the low values in the grass pastures persist for a considerable part of the year. In fact, speaking generally, phosphorus values are below 0·10 per cent. and protein less than 5·0 per cent. for three to six months of the year depending on the area. From a purely qualitative point of view, taking chemical composition as the criterion it seems warranted to conclude that bush pastures are superior to grass pastures under our climatic conditions. However, a conclusion based only on the qualitative indices of pastures cannot under all circumstances be accepted as final. The problem of the quantity and density of edible herbage available and that of the type of animal to be grazed on the pastures must necessarily be taken into consideration. In this connection it may be mentioned that the pastures of Areas 13, 14, 15, 16, 17 and 18 classified botanically as " desert shrub " are best grazed by sheep, the small karroo bushes which are the mainstay of these pastures, especially during dry seasons, being not so suitable for cattle farming. On the other hand, the natural grasslands of the northern provinces and Natal may be utilised for both cattle and sheep. On the whole it may be expected that these grass pastures will yield more food per unit of area than will the bush pastures of the Cape Province. In general it may, therefore, be stated that an animal will require less time and a smaller area to fulfill its daily requirements in regard to the amount of food needed on grass than on " bush " pastures.

A study of the average phosphorus and protein values for each of the 18 areas separately reveals differences in the quality of the pastures not only between the two major groups " grass " and " bush " as indicated above but also within each of these two main types of pasture in the Union.

Areas 1 to 5 comprise practically the whole of the tall grass area lying east of the Drakensberg escarpment and the coastal belt stretching from East London northwards. Of these areas numbers 2 and 5, both including a portion of the coastal belt, may be considered to be superior to Areas 1, 3 and 4, as judged by the average phosphorus and protein contents of the pastures. In the case of phosphorus the graphs show that not only are the maximum values obtained for the summer months higher in the pastures of Areas 2 and 5 than in those of Areas 1, 3 and 4 but also the minimum values for the winter months are appreciably higher in the former than in the latter set of areas. The average protein values in Areas 2 and 5 are likewise better than those in Areas 1, 3 and 4 in that the winter averages do not fall to such low levels. It should be mentioned that a fair percentage of bushes were present in the samples from Area 5.

Of the remaining three areas situated in the typically grassland regions of the Union, viz. Areas 6, 7 and 8, the last two areas may be taken to be practically the same as Areas 1 and 3 with reference to the average phosphorus and protein figures of the pastures from January to December. On the other hand, Area 6, comprising a stretch of country which includes a portion of the north-eastern Cape and eastern half of the Orange Free State shows a definite improvement in comparison with Areas 7 and 8, phosphorus and protein values being on an average higher both during the rainy and dry seasons.

Areas 9, 10, 11 and 12 are situated practically wholly in the Parkland region of South Africa. Although this region is characterised botanically as " open woodland and orchard country of evergreen and deciduous tree and bush, open woodland country of suptropical evergreen and deciduous tree and thorn forest, and thorn country " (Pole Evans, 1936) the samples of edible pasture forwarded from the areas situated in this region were composed mainly of grasses. The position in regard to the phosphorus and protein content of the samples from Areas 9, 11 and 12 is no better than that in, for instance, Area 7. Here again, however, an improvement is noticeable in the case of Area 10, comprising the Letaba and Zoutpansberg districts. About one-sixth of the samples from this area were composed of evergreen deciduous tree and bush, and this circumstance, no doubt, was responsible for higher average phosphorus and protein figures although the improvement in the protein values are not such as to warrant special mention. It is to be noted, however, that in the case of Area 12 covering the Mafeking, Vryburg, Kuruman and Barkley West districts and situated in thorn country with an infiltration of Desert Shrub, the presence of about one quarter of the total samples analysed in the form of bush while improving the average protein figures from January to December did not materially improve the phosphorus figures when compared with an exclusive grassland region like Area 8. The low values obtained for this area in spite of a fair admixture of bushes in the samples, an admixture which in all other cases resulted in higher phosphorus values, bear out the known prevalence of Lamsiekte on the natural pastures of this region.

Of the remaining six areas numbers 13, 14, 15 and 16 lie exclusively in the Desert Shrub region while the vegetation of Areas 17 and 18 covering the north western portion of the Cape Province is mainly composed of desert succulents and desert grass. The phosphorus figures for the latter two areas are as previously pointed out lower than those for the Desert Shrub region but are nevertheless better than the figures for purely grassland areas. The superiority of the Desert Shrub to the grassland country with reference to the phosphorus and protein contents of its pastures has already been referred to. It remains only to point out that judging from the graphs depicting average phosphorus and protein figures Area 14 is somewhat better than Areas 13, 15 and 16.

From a purely qualitative point of view, i.e., judging from their percentage content of the essential nutrients, phosphorus and protein, the natural pastures of the Union may, therefore, be provisionally divided into three categories, viz., those low in phosphorus and protein a second group showing medium values, and, lastly, those pastures containing comparatively high percentages of phosphorus and protein when judged by South African standards. Areas 1, 3, 4, 7, 8, 9, 11, and 12 which includes the greater part of the Grassland region of the Union may be classified in the first category, i.e., low values for phosphorus and protein; Areas 2, 5, 6, 10, 17 and 18 comprising a part of the Tall Grass area the major portion of the Short Grass region, and the whole of the Desert Succulents and Desert Grass area would fall under medium pastures, and finally the Desert Shrub area which has been divided into Areas 13, 14, 15 and 16 may be considered to be comparatively high in phosphorus and protein. Such a division, based as it is on chemical analyses alone, does not of course, finally determine the economic value of the several pastural regions for the production of livestock. As previously stated the amount of food available to the animal in a given area is a factor of paramount importance. In this connection it is of interest to record that according to Pole-Evans (*loc. cit*) in the Desert Shrub and Desert Succulent regions " the plants are always widely spaced in bare soil " while for instance in parts of the Tall Grass area the grasses form " a dense cover and a uniform sward ". Thus an animal on a farm in Namaqualand (Areas 17 or 18—medium P and protein) may die from starvation whilst an animal on a farm in the Dundee district (Area 1—low P and protein in winter) may merely suffer a temporary set back due to a deficiency of protein and phosphorus in an otherwise adequate diet.

In any case, there is no doubt that while grasses show fair figures for phosphorus and protein during the period of active growth associated with the rainy season these values drop to extremely low levels after the cessation of the rains into the cold winter months. On the other hand, while they are undoubtedly influenced by the rainfall, trees, shrubs, and other edible herbaceous plants do not only appear to be on the whole richer in phosphorus and protein than the grasses but they retain these nutritive constituents to a great extent even in the absence of rain.

Before passing on to a consideration of the other constituents determined it will be interesting and instructive to devote some space to a brief discussion of the growth requirements of cattle and sheep for phosphorus and protein in the light of the available information on the subject and with reference to the amounts of the said constituents present in South African natural pastures as shown in the present report.

In order to assess the value of these pastures as sources of phosphorus and protein for the growing animal it is necessary to know, apart from the chemical data here presented, the requirement of the animal for the nutrients, the amount of dry matter it will consume under grazing conditions, and the extent to which the animal organism is able to utilize the ingested nutrients.

It is not necessary to review the literature bearing on the subject of the mineral requirements of animals as this has been ably accomplished in a recent bulletin by Mitchell and McClure (1937). In connection with the calcium and phosphorus requirements of cattle as given in the literature the authors remark that " the results summarised (above) are peculiarly incomplete and contradictory ". For instance, the phosphorus requirement for growth as a percentage of the ration fed ranges from 0·1 to 0·26 per cent. in the said summary of data from the literature. In the publication referred to Mitchell and McClure estimated the daily feed phosphorus requirement of growing Holstein-Friesian cattle (female) at about 10 grams phosphorus and that for growing beef steers at about 12 grams feed phosphorus per day, 70 per cent. of which represents the net phosphorus requirement of these animals. From their experiments at this Institute Theiler *et al* (1937) concluded that 10 grams feed phosphorus daily are adequate for normal growth and development in the case of high-grade Friesland heifers and steers. The figure for the daily phosphorus intake of Merino sheep, viz. 1·53 grams, on which the animals made excellent gains in weight in the experiments of du Toit and co-workers (1930, 1932) is essentially the same as that (1·46 grams) estimated by Mitchell and McClure (*loc. cit.*) as the feed phosphorus requirements of growing Shropshire sheep. Du Toit and collaborators could not register an improvement in the performance of the sheep by increasing the daily phosphorus intake to 2·92 grams and they consequently concluded that " it is practically certain that a daily intake of about 1·53 grams phosphorus is nearer the optimum amount of phosphorus for growing sheep than an intake of 2·92 grams per day ".

According to the data developed in a Report by Mitchell (1929) on the minimum protein requirements of cattle the daily requirement of digestible protein by growing Hereford-Shorthorn calves is estimated to decrease from 0·67 lb. (304 grams) for an animal of 200 lb. live-weight to 0·56 lb. (254 grams) for one weighing 800 lb., or 604 and 508 grams feed crude protein, if the digestibility is taken at 50 per cent. for the two live-weights, respectively. Smuts and Marais (1938) studied the endogenous nitrogen metabolism of the Merino sheep and from their data they calculated the maintenance requirement for protein. In terms of digestible protein the maintenance requirement for a 100-lb. sheep according to these workers is 23·0 grams which expressed as feed protein, assuming a digestion coefficient of 60 per cent., become 38·3 grams. For normal growth the animal will naturelly require an additional amount of protein. Unfortunately no experiments have up to now been conducted in this country with the object of determining the optimum protein requirement for growth of the Merino sheep. In the experiments of du Toit and co-workers already referred to and which aimed at an estimation of the phosphorus requirements of growing sheep the daily feed protein intake of the animals was approximately 68 grams. Since those animals in the experiment whose daily phosphorus intake was 1·53 grams were reported to have made satisfactory gains in weight and to have been in excellent condition at the conclusion of the experiment it seems warranted to utilise the protein intake of these animals as a basis for assessing the capacity of South African pastures to fulfil the protein requirement for growth of the Merino sheep. Compared with, for instance, the figure of 1¾ lb. of digestible protein per week as the requirement for growth and fattening given by Wood and Woodman (1932) the figure of 68 grams feed crude protein per day must be looked upon as a gross underestimation of the protein requirement for normal growth. However, as will become evident presently, any figure for the growth requirement which is higher than the maintenance requirement will suffice to illustrate the shortcomings of South African natural pastures during certain seasons of the year.

Very little information is available on the amount of dry matter different classes of stock will consume while grazing on the open veld. Garrigus (1934) reported figures for the dry matter consumption of grazing steers ranging from 10·2 to 25·8 lb. with an average of 16 lb. per day. Smuts (1939) applied the same method as that employed by Garrigus to grazing sheep and found an average daily dry matter consumption of 660 grams for a sheep weighing between 60 and 70 lb. In view of this finding and in the light of the figures given in the literature (see Mitchell and McClure *[loc. cit]*) for the dry matter requirement of growing sheep it seems safe to assume that a 100-lb. sheep will consume 900-1,000 grams of dry matter under grazing conditions.

The following estimations, then, of the daily requirements of growing sheep and cattle for phosphorus and crude protein in terms of feed phosphorus and feed crude protein and the amount of dry matter they will consume under grazing conditions will be used as criteria for judging the feeding value of South African pastures during different seasons of the year:—

| Species. | Live-weight. | Crude Protein. | Phosphorus. | Dry Matter Consumption. |
|---|---|---|---|---|
| | lb. | Grams. | Grams. | Grams. |
| Cattle................. | 800 | 500 | 10·0 | 7,300 |
| Sheep................. | 100 | 70 | 1·5 | 900 |

Employing the figures given above for the dry matter consumption of grazing cattle and sheep and those describing the average phosphorus and crude protein contents of the natural pastures in Areas 1 to 18 presented in Tables 2 and 3 figures showing the estimated intakes of feed phosphorus and feed crude protein of cattle and sheep on natural veld, for months and areas separately, have been calculated. The data thus obtained are given in Tables 4 and 5 for cattle and in Tables 6 and 7 for sheep.

## TABLE 4.

## *Estimated Phosphorus Intake of Cattle on Natural Veld in Grams per day.*

| Area. | Jan. | Feb. | March. | April. | May. | June. | July. | August. | Sept. | Oct. | Nov. | Dec. | Type of Veld. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8·6 | 7·7 | 7·7 | 7·7 | 5·8 | 4·7 | 3·9 | 4·5 | 5·0 | 6·0 | 9·7 | 9·0 | Grass. |
| 2 | 10·7 | 9·0 | 8·6 | 8·9 | 7·6 | 7·7 | 8·1 | 6·1 | 7·5 | 9·9 | 9·0 | 10·1 | Grass. |
| 3 | 9·6 | 8·8 | 8·0 | 6·9 | 5·8 | 5·1 | 4·8 | 4·5 | 5·8 | 6·9 | 9·8 | 9·6 | Grass. |
| 4 | 6·9 | 6·7 | 7·0 | 7·0 | 6·6 | 5·7 | 6·1 | 5·0 | 6·1 | 7·5 | 8·4 | 9·3 | Grass. |
| 5 | 9·9 | 10·0 | 8·5 | 9·9 | 9·1 | 8·2 | 8·2 | 7·6 | 7·0 | 9·5 | 10·2 | 11·5 | Mainly grass. |
| 6 | 12·6 | 11·5 | 10·1 | 9·1 | 8·3 | 7·7 | 6·0 | 6·1 | 7·4 | 9·4 | 10·0 | 15·5 | Grass. |
| 7 | 9·2 | 8·7 | 6·9 | 7·0 | 4·7 | 4·7 | 4·0 | 4·2 | 5·0 | 5·5 | 10·1 | 10·1 | Grass. |
| 8 | 9·3 | 8·2 | 7·4 | 7·4 | 5·8 | 5·5 | 4·7 | 4·4 | 4·6 | 5·5 | 6·8 | 9·3 | Grass. |
| 9 | 9·6 | 9·3 | 7·7 | 8·0 | 5·3 | 5·5 | 5·0 | 4·5 | 3·3 | 7·4 | 9·1 | 9·2 | Mainly grass. |
| 10 | 11·8 | 11·5 | 10·5 | 9·2 | 9·2 | 8·9 | 8·1 | 7·7 | 5·8 | 6·8 | 13·8 | 13·4 | Mainly grass. |
| 11 | 11·7 | 9·3 | 9·1 | 7·0 | 6·4 | 6·2 | 4·8 | 4·8 | 4·5 | 5·7 | 9·7 | 13·3 | Grass. |
| 12 | 9·6 | 11·2 | 9·0 | 8·8 | 6·4 | 5·2 | 6·9 | 3·9 | 4·3 | 6·3 | 6·5 | 8·8 | Mainly grass. |
| 13 | 15·8 | 13·6 | 12·0 | 13·5 | 11·5 | 10·2 | 12·8 | 10·1 | 7·7 | 9·2 | 13·1 | 14·2 | Grass and bush. |
| 14 | 15·9 | 13·7 | 13·4 | 15·0 | 12·5 | 11·0 | 11·9 | 12·2 | 10·9 | 12·9 | 13·1 | 13·7 | Grass and bush. |
| 15 | 12·2 | 10·7 | 11·5 | 12·0 | 10·4 | 10·9 | 13·1 | 11·4 | 12·3 | 10·7 | 9·6 | 12·8 | Mainly bush. |
| 16 | 10·4 | 10·2 | 11·8 | 10·6 | 11·5 | 9·9 | 11·5 | 13·1 | 10·8 | 10·2 | 11·3 | 10·1 | Mainly bush. |
| 17 | 6·3 | 7·7 | 6·7 | 7·1 | 9·5 | 10·2 | 9·9 | 10·9 | 11·1 | 11·2 | 7·3 | 7·9 | Bush. |
| 18 | 8·5 | 8·2 | 7·9 | 8·1 | 9·7 | 8·8 | 9·3 | 10·7 | 10·4 | 8·5 | 6·1 | 8·8 | Grass and bush. |

### TABLE 5.

### *Estimated Crude Protein Intake of Cattle on Natural Veld in Grams Per Day.*

| Area. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 540 | 467 | 445 | 445 | 321 | 278 | 248 | 255 | 365 | 402 | 657 | 582 |
| 2 | 577 | 475 | 475 | 467 | 387 | 402 | 453 | 321 | 467 | 540 | 591 | 591 |
| 3 | 555 | 482 | 445 | 409 | 321 | 292 | 248 | 241 | 431 | 438 | 657 | 620 |
| 4 | 518 | 453 | 423 | 431 | 394 | 351 | 343 | 329 | 460 | 467 | 598 | 620 |
| 5 | 570 | 548 | 460 | 533 | 482 | 431 | 402 | 416 | 467 | 511 | 598 | 672 |
| 6 | 657 | 504 | 467 | 438 | 358 | 321 | 285 | 307 | 416 | 548 | 613 | 780 |
| 7 | 555 | 497 | 416 | 380 | 292 | 278 | 241 | 241 | 329 | 372 | 657 | 620 |
| 8 | 562 | 511 | 475 | 423 | 314 | 300 | 270 | 248 | 329 | 365 | 475 | 613 |
| 9 | 518 | 533 | 533 | 409 | 372 | 358 | 321 | 263 | 314 | 460 | 628 | 606 |
| 10 | 584 | 598 | 533 | 504 | 445 | 409 | 358 | 314 | 336 | 380 | 760 | 760 |
| 11 | 730 | 638 | 518 | 445 | 351 | 343 | 372 | 292 | 329 | 380 | 738 | 818 |
| 12 | 620 | 664 | 562 | 584 | 496 | 460 | 467 | 365 | 438 | 423 | 570 | 672 |
| 13 | 860 | 613 | 533 | 570 | 664 | 416 | 540 | 518 | 387 | 496 | 766 | 715 |
| 14 | 686 | 642 | 642 | 686 | 598 | 582 | 642 | 570 | 620 | 642 | 722 | 722 |
| 15 | 680 | 504 | 680 | 650 | 526 | 708 | 715 | 664 | 737 | 547 | 606 | 688 |
| 16 | 657 | 540 | 628 | 650 | 664 | 678 | 693 | 664 | 657 | 562 | 752 | 672 |
| 17 | 467 | 438 | 438 | 518 | 672 | 737 | 693 | 700 | 664 | 570 | 570 | 547 |
| 18 | 504 | 475 | 570 | 555 | 606 | 591 | 598 | 613 | 642 | 526 | 504 | 650 |

## TABLE 6.

*Estimated Phosphorus Intake of Sheep on Natural Veld in Grams Per Day.*

| Area. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1·06 | ·95 | ·95 | ·95 | ·71 | ·59 | ·48 | ·56 | ·62 | ·74 | 1·20 | 1·11 |
| 2 | 1·32 | 1·11 | 1·06 | 1·08 | ·94 | ·95 | 1·00 | ·76 | ·93 | 1·22 | 1·11 | 1·24 |
| 3 | 1·19 | 1·09 | 1·00 | ·85 | ·72 | ·63 | ·59 | ·56 | ·71 | ·85 | 1·21 | 1·18 |
| 4 | ·86 | ·83 | ·86 | ·86 | ·81 | ·70 | ·75 | ·62 | ·76 | ·93 | 1·04 | 1·15 |
| 5 | 1·22 | 1·23 | 1·05 | 1·22 | 1·12 | 1·02 | 1·02 | ·94 | ·87 | 1·17 | 1·26 | 1·42 |
| 6 | 1·56 | 1·42 | 1·24 | 1·13 | 1·02 | ·95 | ·74 | ·76 | ·91 | 1·16 | 1·23 | 1·91 |
| 7 | 1·13 | 1·07 | ·86 | ·86 | ·59 | ·59 | ·50 | ·52 | ·61 | ·68 | 1·24 | 1·24 |
| 8 | 1·14 | 1·01 | ·91 | ·92 | ·71 | ·68 | ·58 | ·54 | ·57 | ·68 | ·84 | 1·14 |
| 9 | 1·19 | 1·15 | ·95 | ·98 | ·65 | ·68 | ·62 | ·55 | ·41 | ·91 | 1·12 | 1·13 |
| 10 | 1·45 | 1·41 | 1·30 | 1·13 | 1·13 | 1·10 | 1·00 | ·95 | ·72 | ·84 | 1·70 | 1·65 |
| 11 | 1·44 | 1·15 | 1·12 | ·86 | ·79 | ·77 | ·59 | ·59 | ·55 | ·70 | 1·20 | 1·64 |
| 12 | 1·18 | 1·38 | 1·11 | 1·08 | ·79 | ·64 | ·86 | ·48 | ·53 | ·77 | ·80 | 1·08 |
| 13 | 1·94 | 1·67 | 1·48 | 1·67 | 1·41 | 1·26 | 1·58 | 1·24 | ·95 | 1·13 | 1·62 | 1·76 |
| 14 | 1·96 | 1·69 | 1·65 | 1·85 | 1·54 | 1·36 | 1·47 | 1·50 | 1·35 | 1·59 | 1·62 | 1·68 |
| 15 | 1·50 | 1·32 | 1·42 | 1·48 | 1·28 | 1·35 | 1·61 | 1·40 | 1·51 | 1·31 | 1·19 | 1·58 |
| 16 | 1·29 | 1·26 | 1·46 | 1·31 | 1·42 | 1·22 | 1·42 | 1·62 | 1·33 | 1·26 | 1·40 | 1·25 |
| 17 | ·78 | ·95 | ·83 | ·88 | 1·17 | 1·26 | 1·22 | 1·34 | 1·37 | 1·38 | ·90 | ·97 |
| 18 | 1·05 | 1·01 | ·97 | 1·00 | 1·20 | 1·09 | 1·14 | 1·32 | 1·28 | 1·04 | ·76 | 1·08 |

TABLE 7.

*Estimated Crude Protein Intake of Sheep on Natural Veld in Grams Per Day.*

| Area. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 67 | 58 | 55 | 55 | 40 | 34 | 31 | 32 | 45 | 50 | 81 | 72 |
| 2 | 71 | 59 | 59 | 58 | 48 | 50 | 56 | 40 | 58 | 67 | 73 | 73 |
| 3 | 68 | 59 | 55 | 50 | 40 | 36 | 31 | 30 | 53 | 54 | 81 | 77 |
| 4 | 64 | 56 | 52 | 53 | 49 | 43 | 42 | 41 | 57 | 58 | 74 | 77 |
| 5 | 70 | 68 | 57 | 66 | 59 | 53 | 50 | 51 | 58 | 63 | 74 | 83 |
| 6 | 81 | 62 | 58 | 54 | 44 | 40 | 35 | 38 | 51 | 68 | 76 | 96 |
| 7 | 68 | 61 | 51 | 47 | 36 | 34 | 30 | 30 | 41 | 46 | 81 | 77 |
| 8 | 69 | 63 | 59 | 52 | 39 | 37 | 33 | 31 | 41 | 45 | 59 | 76 |
| 9 | 64 | 66 | 66 | 50 | 46 | 44 | 40 | 32 | 39 | 57 | 77 | 75 |
| 10 | 72 | 74 | 66 | 62 | 55 | 50 | 44 | 39 | 41 | 47 | 94 | 94 |
| 11 | 90 | 77 | 64 | 55 | 43 | 42 | 46 | 36 | 41 | 47 | 91 | 100 |
| 12 | 77 | 82 | 69 | 72 | 61 | 57 | 58 | 45 | 54 | 52 | 70 | 83 |
| 13 | 106 | 76 | 66 | 70 | 82 | 51 | 67 | 64 | 48 | 61 | 95 | 88 |
| 14 | 85 | 79 | 79 | 85 | 74 | 72 | 79 | 70 | 77 | 79 | 89 | 89 |
| 15 | 84 | 62 | 84 | 80 | 65 | 87 | 88 | 82 | 91 | 68 | 75 | 97 |
| 16 | 81 | 67 | 77 | 80 | 82 | 84 | 86 | 82 | 81 | 69 | 93 | 83 |
| 17 | 58 | 54 | 54 | 64 | 83 | 91 | 86 | 86 | 82 | 70 | 70 | 68 |
| 18 | 62 | 59 | 70 | 68 | 75 | 73 | 74 | 76 | 79 | 65 | 62 | 80 |

Since the phosphorus and protein contents of the pastures in the respective areas and in the course of the year have already been discussed it remains only to focus attention on a few outstanding features in connection with the figures giving the estimated intakes of animals on these pastures with reference to their requirements for growth.

A study of the relevant data in Tables 4 and 6 reveals that during the whole year both cattle and sheep seldom ingest sufficient phosphorus for maximum growth on the pastures of Areas 1, 3, 4, 7, 8, 9, 11 and 12. During the summer months when the veld is usually green and succulent the deficiency on the required intake, especially in the case of cattle, is, however, small and may for this reason and in view of the approximate nature of the figure (10 grams phosphorus) representing the requirement for growth be considered as negligible. On the other hand during winter when the veld is dry and brown the intake sometimes falls to as low as only 40 per cent, of the requirement for growth, a deficiency which cannot exist without serious consequences to the well-being and production of the animals. This sub-optimum intake of phosphorus appears to be more serious with sheep than with cattle in the areas mentioned. It should, however, be mentioned that the majority of samples from these areas were collected by following cattle, and since sheep can be expected to graze more selectively than cattle are able to do the phosphorus content of the samples may probably have been somewhat higher had sheep been followed with their collection.

Passing on to the set of areas, viz. Nos. 2, 5, 6, 10, 17 and 18, classified earlier in this discussion as " medium " with regard to the phosphorus and protein contents of their pastures a definite improvement in the phosphorus nutrition of cattle and sheep on these pastures is indicated as judged by the estimated intakes. Not only are the pastures able to provide the optimum requirement for growing cattle for about five months of the year but also during the dry season which corresponds with winter in most areas the intake is not as low as indicated for the first mentioned series of areas.

A glance at the figures giving the estimated intakes of phosphorus on the pastures of areas, Nos. 13, 14, 15 and 16 shows that an intake below the optimum requirement for growing cattle and sheep occurs but seldom in the course of the year. Provided sufficient food is available on the veld the chances of animals suffering from a phosphorus deficiency on these pastures seem to be remote.

In general, the remarks made in connection with the phosphorus nutrition of cattle and sheep on the pastures of Areas 1 to 18 apply equally well to the intake of crude protein on these pastures. Except for Areas 13 to 18 where the estimated intake of crude protein falls at the outside during three months of the year below the estimated requirement for growth the crude protein content of the natural pastures of the Union are for periods ranging from five to nine months of the year, depending on the locality, so low that growth is either seriously retarded or temporarily stopped. In fact, if the feed crude protein maintenance requirement of sheep is taken to be 46·0 grams [Smuts (*loc. cit.*) gave this requirement as 23·0 grams digestible crude protein] an inspection of Table 7 reveals that on some of the grassland pastures the intake of this nutrient may be for several months during winter below the requirement for maintenance.

The phosphorus and protein contents of the natural pastures of South Africa during summer and winter, respectively, have recently been presented as coloured charts in popular fashion in an article in *Farming in South Africa* (June, 1940). These charts are included in the appendix of this report as they present at a glance the outstanding features in the above discussion.

Average values for summer and winter have been calculated and presented in separate charts; "summer" denotes the period November to April—being the period of greatest food abundance—and "winter" extends from May to October, or the period of food scarcity, generally speaking. The key to the coloured charts is given in the following table:—

| Colour. | Percentage Phosphorus (P) in Pasture. | Percentage Protein in Pasture. | Remarks. |
|---|---|---|---|
| Red | Less than 0·09 | Less than 4·5 | Below requirements for growth. |
| Light Red | 0·09 to 0·11 | 4·5—5·0 | |
| Yellow | 0·11 to 0·14 | 5·0 7·0 | Limited growth. |
| Pale blue | 0·14 to 0·18 | 7·0—9·0 | Sufficient for normal growth. |
| Dark blue | More than 0·18 | More than 9·0 | |

It should again be emphasized that in judging the economic value of the pastures in the respective areas as delimitated in this report the question of the available feed supply should not be lost sight of. For instance, the estimated intake of crude protein on the pastures of the North-western Cape (Areas 17 and 18), a region with an average rainfall of only 5 inches per annum, seldom is below the estimated requirements for growth, but, on the other hand, it is a matter of common experience in this region that animals die at times from sheer starvation; the amount of food available becomes the limiting factor.

To conclude these remarks on the phosphorus and protein contents of our natural pastures in relation to the needs for growth of animals reference may be made to the fact that the requirements for growth only of a 800 lb. bovine and a 100 lb. sheep have been chosen as the basis for assessing the feeding value of the pastures. Younger animals may be expected to consume less dry matter than the amounts taken to be the capacity of the above-mentioned animals, so that, assuming the growth requirements to be the same, it will mean that the percentages of phosphorus and crude protein in their diet should be higher than in that of older animals; a circumstance which will result in the shortening or the total absence of a period of optimum growth in the case of younger stock on our natural pastures. Similar remarks are valid in the case of pregnant or lactating animals in that amounts of phosphorus and crude protein superimposed in many cases on the requirements for growth have to be allowed for in the ration. In any case, from what has been said it is clear that most of the natural pastures of this country should be either improved or supplemented during the greater part of the year to ensure continuous production by animals.

### (3) CALCIUM AND MAGNESIUM.

Unlike phosphorus and protein the averages for calcium and magnesium given in Tables 8 and 9 fluctuate only slightly from month to month. They show, however, no definite tendency and remain in general fairly constant throughout the year. As in the case of phosphorus and protein the major difference with reference to the calcium and magnesium contents of the pastures of the Union is encountered as one passes from the all-grass to the mixed and all-bush pastures, the latter veld type being invariably richer in both calcium and magnesium than the first mentioned type. This circumstance is consequently held responsible for greater month to month fluctuations in the percentages of calcium and magnesium in areas where the samples were composed of varying amounts of bushes and grasses.

The calcium figures for the grassland Areas 1 to 8 fluctuate around 0·30 per cent. and the magnesium values around 0·14 per cent., except for Area 5, with a fair admixture of bushes in the samples analysed which shows better values for calcium than any of the areas mentioned, values fluctuating between 0·34 and 0·40 per cent. from January to December, and Area 4 in which the monthly averages for calcium vary between only 0·22 and 0·31 per cent. with an annual average of about 0·25 per cent. Compared with data from the British Isles, these figures for Ca are definitely low. In fact they may be compared with the figures obtained for " not eaten " herbage of the Scottish hill pastures (Godden, 1926) a statement which should, however, not be taken to imply that these South African pastures are deficient in calcium.

Areas 9, 10 and 11 situated in the Parkland region of the Transvaal show higher figures for the two constituents under discussion in comparison with the typical grasslands of Natal and the Orange Free State. Average monthly values fluctuate on a higher plane and the annual averages for calcium in the case of the three areas are 0·42, 0·48 and 0·40 per cent., respectively. Magnesium values, also, are higher, being around 0·18, 0·21 and 0·19 on an average for the three areas.

The pastures of the remaining seven Areas 12 to 18 comprising the Desert Shrub region of the country may be considered to be rich in calcium and magnesium, the figures being comparable to those for cultivated pastures overseas. Corresponding on the whole with an increasing number of samples composed of bushes only (see tables in appendix) in the total number analysed the calcium and magnesium figures rise steadily from Area 12 to Area 18. There are, of course, fluctuations in the average monthly values in each area but

### TABLE 8.

*Mean Calcium (Ca) content of Pastures. (Range values included.)*

| Area. | January. | February. | March. | April. | May. | June. | July. | August. | Sept. | Oct. | Nov. | Dec. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **·29** | **·28** | **·29** | **·30** | **·32** | **·30** | **·29** | **·27** | **·32** | **·26** | **·28** | **·28** | **Mean.** |
| | ·16–·62 | ·18–·44 | ·19–·53 | ·18–·43 | ·16–·63 | ·13–·54 | ·18–·53 | ·17–·41 | ·18–·57 | ·12–·48 | ·16–·74 | ·18–·60 | Range. |
| 2 | **·29** | **·27** | **·32** | **·30** | **·29** | **·32** | **·35** | **·26** | **·31** | **·29** | **·27** | **·31** | **Mean.** |
| | ·13–·78 | ·13–·95 | ·12–·81 | ·11–·80 | ·14–·55 | ·15–·73 | ·15–1·04 | ·14–·59 | ·12–·75 | ·13–·86 | ·14–·62 | ·14–·97 | Range. |
| 3 | **·27** | **·29** | **·28** | **·30** | **·31** | **·29** | **·29** | **·30** | **·26** | **·25** | **·29** | **·28** | **Mean.** |
| | ·16–·44 | ·16–·53 | ·15–·45 | ·18–·49 | ·18–·58 | ·13–·51 | ·16–·54 | ·18–·46 | ·15–·42 | ·16–·42 | ·18–·66 | ·15–·65 | Range. |
| 4 | **·23** | **·24** | **·25** | **·26** | **·31** | **·27** | **·26** | **·24** | **·22** | **·23** | **·23** | **·24** | **Mean.** |
| | ·18–·29 | ·14–·35 | ·12–·45 | ·18–·33 | ·14–·57 | ·18–·45 | ·15–·73 | ·16–·37 | ·13–·34 | ·16–·36 | ·16–·31 | ·17–·33 | Range. |
| 5 | **·35** | **·39** | **·34** | **·39** | **·37** | **·37** | **·36** | **·40** | **·37** | **·38** | **·37** | **·35** | **Mean.** |
| | ·18–·71 | ·16–1·12 | ·19–1·19 | ·21–·85 | ·18–·82 | ·16–·93 | ·19–·70 | ·21–1·22 | ·19–1·09 | ·17–·93 | ·17–·79 | ·18–·79 | Range. |
| 6 | **·30** | **·30** | **·34** | **·34** | **·35** | **·31** | **·32** | **·31** | **·31** | **·32** | **·30** | **·36** | **Mean.** |
| | ·17–·55 | ·17–·80 | ·23–·88 | ·18–·56 | ·21–·64 | ·23–·68 | ·19–·61 | ·17–·65 | ·14–·53 | ·18–·94 | ·17–·48 | ·18–1·22 | Range. |
| 7 | **·29** | **·30** | **·33** | **·33** | **·31** | **·30** | **·31** | **·29** | **·32** | **·28** | **·27** | **·31** | **Mean.** |
| | ·17–·46 | ·15–·72 | ·17–·72 | ·16–·59 | ·16–·92 | ·14–·51 | ·16–·54 | ·20–·40 | ·11–·58 | ·11–·48 | ·10–·70 | ·16–·59 | Range. |
| 8 | **·29** | **·28** | **·32** | **·32** | **·34** | **·34** | **·34** | **·32** | **·32** | **·32** | **·27** | **·31** | **Mean.** |
| | ·17–·53 | ·19–·54 | ·17–·53 | ·21–·47 | ·16–·57 | ·18–·62 | ·16–·51 | ·16–·63 | ·19–·54 | ·13–·56 | ·15–·49 | ·16–·56 | Range. |
| 9 | **·32** | **·37** | **·56** | **·37** | **·41** | **·59** | **·40** | **·33** | **·53** | **·34** | **·35** | **·45** | **Mean.** |
| | ·14–·70 | ·16–1·39 | ·14–1·76 | ·18–1·19 | ·18–1·34 | ·12–2·59 | ·18–1·77 | ·17–·65 | ·11–3·57 | ·14–·91 | ·15–1·00 | ·18–1·78 | Range. |
| 10 | **·40** | **·44** | **·49** | **·50** | **·46** | **·49** | **·50** | **·54** | **·43** | **·43** | **·54** | **·49** | **Mean.** |
| | ·21–1·08 | ·20–1·59 | ·18–1·05 | ·20–1·82 | ·21–1·55 | ·15–1·02 | ·11–1·44 | ·20–1·86 | ·14–1·20 | ·13–1·20 | ·16–1·41 | ·16–1·29 | Range. |
| 11 | **·40** | **·36** | **·37** | **·37** | **·37** | **·38** | **·40** | **·42** | **·42** | **·37** | **·48** | **·48** | **Mean.** |
| | ·22–·69 | ·22–·93 | ·17–·94 | ·17–1·30 | ·22–·89 | ·15–1·38 | ·20–1·16 | ·20–2·04 | ·17–1·73 | ·14–·91 | ·20–2·08 | ·21–1·34 | Range. |
| 12 | **·49** | **·61** | **·61** | **·70** | **·69** | **·62** | **·74** | **·56** | **·49** | **·52** | **·56** | **·62** | **Mean.** |
| | ·17–1·22 | ·28–1·34 | ·25–1·95 | ·28–1·60 | ·29–1·09 | ·21–1·54 | ·16–2·35 | ·18–1·68 | ·21–·92 | ·23–1·43 | ·14–1·07 | ·12–1·64 | Range. |
| 13 | **·64** | **·46** | **·41** | **·66** | **·84** | **·56** | **·75** | **·70** | **·49** | **·53** | **·60** | **·38** | **Mean.** |
| | ·21–1·79 | ·32–·71 | ·20–·73 | ·23–1·04 | ·22–1·63 | ·19–·98 | ·39–1·34 | ·26–1·21 | ·25–·96 | ·21–1·11 | ·28–1·01 | ·20–·70 | Range. |
| 14 | **·45** | **·47** | **·67** | **·79** | **·68** | **·75** | **·72** | **·56** | **·72** | **·71** | **·61** | **·48** | **Mean.** |
| | ·24–·72 | ·22–·90 | ·29–1·48 | ·22–1·47 | ·33–1·28 | ·31–1·19 | ·40–1·33 | ·26–·84 | ·36–1·52 | ·26–1·65 | ·35–1·04 | ·29–·89 | Range. |
| 15 | **·75** | **·85** | **·81** | **·91** | **·78** | **·85** | **·89** | **·99** | **·90** | **·89** | **·81** | **·86** | **Mean.** |
| | ·34–1·09 | ·30–1·85 | ·24–1·36 | ·47–1·65 | ·37–1·49 | ·28–1·36 | ·46–1·55 | ·63–1·68 | ·21–1·80 | ·42–1·43 | ·28–1·68 | ·20–1·15 | Range. |
| 16 | **·91** | **·78** | **·86** | **·92** | **·95** | **·94** | **·92** | **1·05** | **1·06** | **·89** | **·89** | **·81** | **Mean.** |
| | ·26–1·61 | ·39–1·36 | ·39–2·05 | ·44–2·10 | ·35–2·01 | ·28–1·53 | ·37–1·35 | ·65–1·55 | ·38–1·68 | ·37–1·52 | ·39–1·54 | ·24–1·28 | Range. |
| 17 | **1·03** | **·66** | **·79** | **1·04** | **1·04** | **1·01** | **1·13** | **1·25** | **1·09** | **1·13** | **1·02** | **·82** | **Mean.** |
| | ·37–2·95 | ·25–1·08 | ·13–1·60 | ·34–2·11 | ·52–2·43 | ·56–1·59 | ·88–1·48 | ·76–1·99 | ·41–1·83 | ·77–1·59 | ·33–1·85 | ·36–1·15 | Range. |
| 18 | **·86** | **1·12** | **1·26** | **1·07** | **·93** | **·94** | **1·10** | **1·14** | **1·11** | **1·06** | **1·09** | **·96** | **Mean.** |
| | ·35–2·03 | ·62–1·79 | ·29–2·41 | ·38–2·48 | ·31–1·52 | ·33–1·23 | ·59–1·84 | ·43–1·80 | ·52–2·14 | ·40–1·82 | ·38–2·19 | ·30–2·58 | Range. |

## TABLE 9.

*Mean Magnesium (Mg) content of Pastures. (Range values included.)*

| Area. | January. | February | March | April. | May. | June. | July. | August. | Sept. | October. | Nov. | Dec. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ·16 | ·14 | ·15 | ·15 | ·15 | ·13 | ·13 | ·13 | ·11 | ·11 | ·14 | ·14 | **Mean.** |
| | ·08– ·28 | ·04– ·29 | ·06– ·37 | ·07– ·29 | ·06– ·27 | ·06– ·40 | ·06– ·40 | ·06– ·37 | ·04– ·20 | ·03– ·33 | ·05– ·39 | ·08– ·21 | Range. |
| 2 | ·18 | ·15 | ·15 | ·16 | ·16 | ·17 | ·17 | ·13 | ·15 | ·16 | ·15 | ·16 | **Mean.** |
| | ·07– ·50 | ·07– ·44 | ·05– ·47 | ·06– ·35 | ·06– ·34 | ·04– 48 | ·06– ·39 | ·05– ·48 | ·03– ·37 | ·03– ·33 | ·05– ·44 | ·05– ·32 | Range. |
| 3 | ·14 | ·15 | ·13 | ·13 | ·13 | ·12 | ·12 | ·12 | ·10 | ·11 | ·14 | ·13 | **Mean.** |
| | ·06– ·29 | ·08– ·27 | ·05– ·20 | ·08– ·22 | ·07– ·30 | ·06– ·28 | ·05– ·27 | ·06– ·23 | ·04– ·25 | ·04– ·25 | ·08– ·25 | ·05– ·24 | Range. |
| 4 | ·15 | ·14 | ·14 | ·14 | ·17 | ·14 | ·13 | ·12 | ·12 | ·13 | ·13 | ·14 | **Mean.** |
| | ·08– ·21 | ·08– ·21 | ·07– ·23 | ·06– ·32 | ·05– ·33 | ·06– ·27 | ·04– ·21 | ·04– ·23 | ·06– ·24 | ·09– ·17 | ·08– ·17 | ·08– ·20 | Range. |
| 5 | ·16 | ·15 | ·12 | ·16 | ·15 | ·13 | ·12 | ·14 | ·13 | ·15 | ·14 | ·15 | **Mean.** |
| | ·05– ·38 | ·06– ·39 | ·06–· 26 | ·08– ·36 | ·07– ·37 | ·06– ·45 | ·06– ·23 | ·08– 40 | ·05– ·46 | ·05– ·39 | ·06– ·32 | ·06– ·30 | Range. |
| 6 | ·14 | ·12 | ·13 | ·12 | ·12 | ·09 | ·11 | ·12 | ·09 | ·11 | ·13 | ·16 | **Mean.** |
| | ·07– ·24 | ·04– ·27 | ·07– ·31 | ·05– ·24 | ·05– ·24 | ·05– ·20 | ·07– ·19 | ·07– ·24 | ·03– ·17 | ·04– ·26 | ·07– ·20 | ·07– ·42 | Range. |
| 7 | ·17 | ·17 | ·15 | ·17 | ·15 | ·13 | ·11 | ·13 | ·12 | ·11 | ·14 | ·17 | **Mean.** |
| | ·11– ·32 | ·06– ·44 | ·08– ·38 | ·09– ·51 | ·07– ·37 | ·04– ·25 | ·06– ·18 | ·07– ·21 | ·04– ·21 | ·03– ·23 | ·06–·22 | ·09– ·54 | Range. |
| 8 | ·13 | ·14 | ·13 | ·12 | ·13 | ·12 | ·11 | ·12 | ·11 | ·10 | ·11 | ·14 | **Mean.** |
| | ·07– ·25 | ·06– ·27 | ·04– ·28 | ·06– ·21 | ·06– ·21 | ·07– ·28 | ·06– ·18 | ·07– ·17 | ·06– ·20 | ·03– ·19 | ·06– ·18 | ·08– ·28 | Rango. |
| 9 | ·18 | ·19 | ·24 | ·18 | ·20 | ·21 | ·16 | ·15 | ·16 | ·15 | ·18 | ·21 | **Mean.** |
| | ·09– ·30 | ·07– ·62 | ·09– ·65 | ·08– ·39 | ·07– ·52 | ·06– ·65 | 05– ·40 | ·08– ·32 | ·05– ·66 | ·05–·35 | ·08– ·54 | ·07- ·55 | Range. |
| 10 | ·22 | ·22 | ·25 | ·22 | ·22 | ·21 | ·19 | ·20 | ·19 | ·17 | ·21 | ·24 | **Mean.** |
| | ·06– ·49 | ·12– ·40 | ·07– ·54 | ·10– ·60 | ·06– ·51 | 06– ·39 | ·08– ·39 | ·07– ·44 | ·07– ·42 | ·06– ·48 | ·06– 40 | ·09– ·44 | Range. |
| 11 | ·23 | ·21 | ·18 | ·18 | ·17 | ·16 | ·18 | ·17 | ·16 | ·17 | ·22 | ·26 | **Mean.** |
| | ·12– ·50 | ·11– ·55 | ·06– ·49 | ·10– ·54 | ·09– ·40 | ·09– ·43 | ·07– ·64 | ·07– ·60 | ·15– ·40 | ·06– ·58 | ·08–1·05 | ·11– ·57 | Range. |
| 12 | ·19 | ·28 | ·23 | ·24 | ·24 | ·20 | ·23 | ·14 | ·16 | ·15 | ·21 | ·29 | **Mean.** |
| | ·05– ·50 | ·10– ·69 | ·06– ·70 | ·06– ·46 | ·04– ·47 | ·06– ·58 | ·06– ·68 | ·05– ·27 | ·04– ·35 | ·06– ·40 | ·03– ·54 | ·02– ·76 | Range. |
| 13 | ·37 | ·22 | ·23 | ·25 | ·35 | ·21 | ·30 | ·27 | ·16 | ·19 | ·25 | ·18 | **Mean.** |
| | ·11–1·05 | ·05– ·48 | ·07– ·45 | ·09– ·51 | ·07– ·95 | ·07– ·44 | ·12– ·59 | ·10– ·57 | ·07– ·34 | ·06– ·40 | ·07– ·40 | ·09– ·31 | Range. |
| 14 | ·21 | ·23 | ·30 | ·32 | ·27 | ·28 | ·26 | ·25 | ·28 | ·33 | ·24 | ·20 | **Mean.** |
| | ·10– ·31 | ·07– ·59 | ·11– ·92 | ·13– ·74 | ·10– ·58 | ·11– ·48 | ·10– ·67 | ·14– ·50 | 10·– ·69 | ·14– ·99 | ·12– ·45 | ·10– ·28 | Range. |
| 15 | ·41 | ·19 | ·36 | ·37 | ·26 | ·34 | ·33 | ·34 | ·38 | ·29 | ·27 | ·33 | **Mean.** |
| | ·10– ·95 | ·09– ·30 | ·07– ·56 | ·18– ·60 | ·10– ·51 | ·08– ·76 | ·14– ·73 | ·17– ·68 | ·04– ·75 | ·10– ·58 | ·08– ·55 | ·11– ·56 | Range. |
| 16 | ·34 | ·27 | ·26 | ·34 | ·31 | ·31 | ·35 | ·34 | ·31 | ·35 | ·30 | ·26 | **Mean.** |
| | ·12– ·54 | ·10– ·69 | ·09 ·56 | ·15– ·84 | ·12– ·51 | ·10– ·61 | ·13– ·70 | ·21– ·68 | ·17– ·63 | ·12– ·60 | ·14– ·40 | ·08– ·51 | Range. |
| 17 | ·35 | ·19 | ·23 | ·43 | ·31 | ·44 | ·36 | ·48 | ·47 | ·46 | ·36 | ·32 | **Mean.** |
| | ·14– ·60 | ·06– ·29 | ·07– ·48 | ·16– ·73 | ·14– ·65 | ·26– ·73 | ·22– ·56 | ·25– 74 | ·15– ·73 | ·27– ·60 | ·18– ·65 | ·13– ·48 | Range. |
| 18 | ·26 | ·29 | ·33 | ·30 | ·26 | ·38 | 32 | ·34 | ·34 | ·34 | ·32 | ·28 | **Mean.** |
| | ·05– ·40 | ·13– ·45 | ·12– ·54 | ·06– ·71 | ·08– ·60 | ·13– ·70 | 1·0– ·57 | ·08– ·68 | ·16– ·48 | ·14– ·56 | ·14– ·67 | ·08– ·55 | Range. |

as these appear to show no definite tendency the annual average, i.e. the mean of the twelve monthly averages is taken as the criterion. The calcium figures calculated in this manner are 0·60, 0·59, 0·63, 0·86, 0·92, 1·00 and 1·05 for Areas 12, 13, 14, 15, 16, 17 and 18, respectively, while the magnesium values are 0·21, 0·25, 0·26, 0·32, 0·31, 0·37 and 0·31 in corresponding order. The calcium content of the Desert Succulent and Desert Grass pastures of Namaqualand (Area 18) in the west is thus seen to be about four times more than that of the Tall Grass pastures around Port Shepstone in the southern part of Natal on the East Coast of South Africa.

Mitchell and McClure (*loc. cit*) estimated the feed calcium requirement for growth of a Holstein-Friesian heifer weighing 800 lb. at 7·1 grams and that of a growing beef steer of the same weight at 10·4 grams. Pasture containing a minimum of 0·14 per cent. calcium on the basis of the dry matter is, therefore, necessitated by the calcium requirement for growth of a 800 lb. beef steer consuming 16 lb. dry matter per day. The necessary percentage of calcium in the feed would again be higher in the case of younger animals since on the one hand the daily feed calcium requirement itself is higher and, on the other hand, younger stock may be expected to consume less dry matter. The feed calcium requirement of a pregnant Holstein-Fresian cow weighing 1,000 lb. is given by the same authors in terms of the average for the whole gestation period as 11·8 grams per day. Also, a lactating animal of the same weight producing 2 gallons of milk per day will require 19·6 grams feed calcium including its maintenance requirement. To ingest the necessary amount of calcium the latter animal will, therefore, have to consume 16 lb. of a ration containing 0·27 per cent. calcium. Finally, the necessary calcium content of the dry ration for growing Shropshire sheep is estimated to vary between 0·11 and 0·17 per cent., depending on the age and sex of the animal. A comparison of the estimated requirements given above in terms of percentages of the dry ration with the average calcium values for South African pastures presented in Table 8 indicates that cattle or sheep grazing on these pastures are not likely to suffer from a calcium deficiency as such if milk production remains moderate. A cow producing more milk than the amount (2 gallons) stated will naturally require more calcium in its diet. The calcium content of some pastures (e.g. Area 4) may be considered inadequate to fulfil the higher demand for calcium, but, on the other hand, since the production of milk will in any case be seriously curtailed by a deficiency of nutrients such as phosphorus and protein in most pastures calcium cannot in the first place be considered a limiting factor in milk production on South African natural pastures.

According to du Toit and associates (1934) it is doubtful whether a deficiency of magnesium will ever occur in the diet of animals on pasture. These authors were able to lower the magnesium content of their basal ration to 0·11 per cent., but the amount of magnesium ingested with this ration was at least five times the amount of magnesium secreted in two gallons of milk. Reference to Table 9 shows that the magnesium content of South African pastures rarely falls below 0·10 per cent.

## TABLE 10.

### *Mean Potassium (K) Content of Pastures. (Range Values included.)*

| Area. | January. | February. | March. | April. | May. | June. | July. | August. | Sept. | October. | Nov. | Dec. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **1·40** | **1·28** | **1·15** | **1·07** | **·74** | **·58** | **·39** | **·41** | **·52** | **·72** | **1·30** | **1·37** | **Mean.** |
| | ·79–4·02 | ·40–2·07 | ·47–4·34 | ·41–4·27 | ·27–1·65 | ·20–1·73 | ·10–1·44 | ·09–1·34 | ·13–1·62 | ·17–2·05 | ·40–2·47 | ·74–2·42 | Rang. |
| 2. | **1·64** | **1·25** | **1·10** | **1·07** | **·88** | **·80** | **·78** | **·53** | **·75** | **1·07** | **1·21** | **1·45** | **Mean.** |
| | ·53–3·75 | ·58–2·63 | ·29–2·40 | ·32–2·75 | ·31–2·36 | ·17–2·10 | ·14–2·45 | ·10–1·63 | ·03–2·22 | ·17–3·37 | ·36–3·33 | ·33–3·51 | Range. |
| 3 | **1·34** | **1·19** | **·90** | **·82** | **·62** | **·53** | **·34** | **·29** | **·57** | **·62** | **1·22** | **1·34** | **Mean.** |
| | ·52–2·66 | ·38–2·05 | ·46–1·71 | ·39–1·53 | ·23–1·07 | ·19–1·74 | ·16– ·95 | ·15– ·86 | ·12–1·96 | ·07–1·72 | ·34–2·00 | ·70–2·11 | Range. |
| 4 | **1·03** | **·97** | **·78** | **·84** | **·65** | **·57** | **·52** | **·50** | **·64** | **·81** | **·99** | **1·32** | **Mean.** |
| | ·33–1·63 | ·34–1·92 | ·46–1·37 | ·29–2·39 | ·35–1·22 | ·19–1·32 | ·18–2·59 | ·12–1·53 | ·21–2·12 | ·26–2·50 | ·36–2·04 | ·73–1·88 | Range. |
| 5 | **1·33** | **1·36** | **1·00** | **1·16** | **1·04** | **·80** | **·69** | **·62** | **·79** | **·98** | **1·32** | **1·56** | **Mean.** |
| | ·35–2·29 | ·39–2·60 | ·24–2·05 | ·33–2·90 | ·38–2·53 | ·28–2·17 | ·24–2·56 | ·14–1·38 | ·13–2·28 | ·13–3·56 | ·33–3·05 | ·59–3·54 | Range. |
| 6 | **1·75** | **1·32** | **1·17** | **·92** | **·70** | **·58** | **·41** | **·43** | **·59** | **·86** | **1·17** | **1·84** | **Mean.** |
| | ·80–4·22 | ·60–2·84 | ·73–2·39 | ·34–2·35 | ·30–1·46 | ·18–1·29 | ·11– ·98 | ·09–1·08 | ·14–1·96 | ·14–1·71 | ·29–2·15 | 1·05–4·04 | Range. |
| 7 | **1·49** | **1·40** | **1·00** | **·95** | **·67** | **·49** | **·38** | **·31** | **·46** | **·55** | **1·37** | **1·61** | **Mean.** |
| | ·87–2·59 | ·71–2·76 | ·57–1·78 | ·31–2·82 | ·11–1·65 | ·10–1·39 | ·13– ·80 | ·09– ·75 | ·06–1·98 | ·12–1·53 | ·55–2·35 | ·72–2·29 | Range. |
| 8 | **1·55** | **1·39** | **1·15** | **·93** | **·66** | **·52** | **·37** | **·30** | **·44** | **·54** | **·92** | **1·56** | **Mean.** |
| | ·60–2·76 | ·66–2·40 | ·43–2·63 | ·36–1·49 | ·28–1·35 | ·20–1·17 | ·18– ·79 | ·13– ·7C | ·09–1·69 | 09·–1·51 | ·20–1·90 | ·84–2·36 | Range. |
| 9 | **1·55** | **1·42** | **1·24** | **1·06** | **·82** | **·73** | **·54** | **·48** | **·39** | **·71** | **1·45** | **1·70** | **Mean.** |
| | ·70–2·63 | ·80–3·13 | ·55–2·70 | ·46–2·01 | ·27–2·01 | ·24–1·80 | ·11–1·03 | ·13–· 99 | ·04–1·30 | ·17–2·26 | ·21–4·56 | ·58–3·47 | Range. |
| 10 | **1·85** | **1·89** | **1·51** | **1·47** | **1·18** | **·95** | **·84** | **·67** | **·60** | **·63** | **1·67** | **2·13** | **Mean.** |
| | ·29–3·15 | ·89–3·61 | ·39–2·51 | ·61–4·45 | ·40–2·53 | ·21–1·89 | ·18–1·64 | ·25–1·10 | ·22–1·23 | ·04–1·69 | ·24–3·73 | ·52–4·03 | Range. |
| 11 | **2·07** | **1·79** | **1·42** | **1·16** | **·91** | **·68** | **·73** | **·57** | **·46** | **·57** | **1·67** | **2·31** | **Mean.** |
| | ·81–3·61 | ·70–3·79 | ·40–3·70 | ·45–2·36 | ·32–2·11 | ·16–2·18 | ·14–1·78 | ·14–1·64 | ·07–1·66 | ·11–2·59 | ·33–4·24 | ·86–4·15 | Range. |
| 12 | **1·40** | **1·77** | **1·37** | **1·40** | **1·13** | **·79** | **·95** | **·63** | **·78** | **·71** | **·89** | **1·44** | **Mean.** |
| | ·24–2·67 | 1·05–2·50 | ·50–2·61 | ·50–2·06 | ·31–2·01 | ·26–2·02 | ·23–2·36 | ·17–1·08 | ·33–1·28 | ·23–1·60 | ·15–1·70 | ·11–2·73 | Range. |
| 13 | **2·28** | **1·75** | **1·52** | **1·48** | **1·61** | **·96** | **1·24** | **1·07** | **·58** | **·89** | **1·53** | **1·84** | **Mean.** |
| | ·76–3·56 | ·91–2·76 | ·65–2·39 | ·85–3·12 | ·31–3·04 | ·25–1·98 | ·49–1·88 | ·38–2·45 | ·11– ·92 | ·16–1·65 | ·73–2·28 | 1·01–2·59 | Range. |
| 14 | **1·82** | **1·76** | **1·72** | **1·80** | **1·67** | **1·40** | **1·27** | **1·36** | **1·50** | **1·62** | **1·80** | **1·86** | **Mean.** |
| | ·84–2·88 | ·84–3·32 | ·94–2·87 | ·83–3·16 | ·62–3·17 | ·60–2·13 | ·42–2·25 | ·51–2·65 | ·52–2·70 | ·72–2·91 | 1·01–2·69 | 1·23–2·85 | Range. |
| 15 | **2·09** | **1·25** | **1·08** | **1·65** | **1·39** | **1·37** | **1·66** | **1·51** | **1·64** | **1·58** | **1·39** | **1·94** | **Mean.** |
| | ·98–5·73 | ·53–1·88 | ·62–2·70 | ·69–2·95 | ·37–2·38 | ·49–2·41 | ·85–2·83 | ·78–2·70 | ·26–5·78 | ·43–2·70 | ·60–2·40 | 1·08–3·17 | Range. |
| 16 | **1·73** | **1·46** | **1·47** | **1·72** | **1·56** | **1·49** | **1·55** | **1·74** | **1·62** | **1·49** | **1·75** | **1·78** | **Mean.** |
| | 1·10–2·49 | ·87–3·13 | ·54–2·16 | 1·14–2·50 | ·67–2·50 | ·52–2·72 | ·93–2·57 | 1·04–2·86 | ·86–2·77 | ·51–2·19 | ·84–3·24 | ·24–2·68 | Range. |
| 17 | **1·17** | **1·00** | **·95** | **1·19** | **1·23** | **1·56** | **1·55** | **2·09** | **1·74** | **1·65** | **1·34** | **1·42** | **Mean.** |
| | ·67–1·64 | ·56–2·07 | ·42–1·46 | ·41–1·71 | ·61–2·91 | ·83–2·12 | 1·31–1·79 | 1·13–3·16 | ·95–2·86 | 1·02–3·17 | ·72–1·80 | ·85–2·21 | Range. |
| 18 | **1·38** | **1·29** | **1·36** | **1·28** | **1·25** | **1·34** | **1·33** | **1·66** | **1·77** | **1·62** | **1·05** | **1·33** | **Mean.** |
| | ·15–2·31 | ·68–1·69 | ·75–2·70 | ·50–2·43 | ·42–2·03 | ·68–2·03 | ·92–1·90 | ·55–2·98 | ·96–2·81 | ·83–2·59 | ·49–1·65 | ·75–2·58 | Range. |

## TABLE 11.

*Mean Sodium (Na) Content of Pastures. (Range Values included.)*

| Area. | January. | February. | March. | April. | May. | June. | July. | August. | Sept. | October. | Nov. | Dec. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **·04** | **·04** | **·04** | **·07** | **·03** | **·02** | **·03** | **·02** | **·03** | **·05** | **·05** | **·05** | **Mean.** |
| | tr.–·26 | tr.–·27 | tr.–·28 | tr.–·60 | tr.–·26 | tr.–·38 | tr.–·35 | tr.–·12 | tr.–·17 | tr.–·28 | tr.–·25 | tr.–·28 | Range. |
| 2 | **·20** | **·16** | **·12** | **·15** | **·14** | **·16** | **·15** | **·08** | **·17** | **·21** | **·14** | **·18** | **Mean.** |
| | ·03–·53 | ·03–·51 | ·02–·57 | ·02–·47 | ·01–·77 | tr.–1·40 | ·01–·78 | ·01–·79 | tr.–1·02 | ·01–1 12 | tr.–1·07 | ·02–·45 | Range. |
| 3 | **·06** | **·05** | **·02** | **·05** | **·03** | **·03** | **·03** | **·02** | **·05** | **·04** | **·04** | **·07** | **Mean.** |
| | tr.–·38 | tr.–·24 | tr.–·07 | tr.–·17 | tr.–·15 | tr.–·15 | tr.–·21 | tr.–·10 | tr.–·18 | tr.–·14 | tr.–·14 | tr.–·28 | Range. |
| 4 | **·11** | **·13** | **·12** | **·11** | **·14** | **·10** | **·12** | **·10** | **·16** | **·18** | **·20** | **·17** | **Mean.** |
| | tr.–·24 | tr.–·36 | ·01–·34 | tr.–·41 | ·02–·51 | tr.–·76 | ·01–·42 | tr.–·28 | ·02–·55 | tr.–·47 | ·04–·56 | ·03–·38 | Range. |
| 5 | **·25** | **·18** | **·12** | **·21** | **·14** | **·17** | **·14** | **·15** | **·18** | **·16** | **·21** | **·17** | **Mean.** |
| | ·01–1·85 | tr.–·75 | tr.–·43 | ·01–1·27 | ·01–·42 | tr.–1·42 | tr.–1·25 | tr.–·82 | tr.–1·59 | tr.–·94 | tr.–1·64 | ·02–·90 | Range. |
| 6 | **·04** | **·03** | **·03** | **·03** | **·02** | **·01** | **·01** | **·02** | **·03** | **·04** | **·04** | **·07** | **Mean.** |
| | tr.–·15 | tr.–·24 | tr.–·09 | tr.–·07 | tr.–·09 | tr –·04 | tr.–·07 | tr.–·08 | tr.–·07 | tr.–·27 | tr.–·32 | tr.–·36 | Range. |
| 7 | **·05** | **·04** | **·04** | **·03** | **·03** | **·02** | **·02** | **·03** | **·04** | **·05** | **·03** | **·06** | **Mean.** |
| | tr.–·22 | tr.–·20 | tr.–·32 | tr.–·12 | tr.–·20 | tr.–·13 | tr.–·11 | tr.–·32 | tr.–·16 | tr.–·27 | tr.–·08 | tr. ·41 | Range. |
| 8 | **·04** | **·04** | **·02** | **·04** | **·02** | **·01** | **·01** | **·01** | **·03** | **·02** | **·05** | **·07** | **Mean.** |
| | tr.–·18 | tr.–·38 | tr.–·07 | tr.–·14 | tr.–·04 | tr.–·09 | tr.–·04 | tr.–·07 | tr.–·21 | tr.–·09 | tr.–·29 | tr.–·45 | Range. |
| 9 | **·12** | **·13** | **·09** | **·14** | **·05** | **·06** | **·05** | **·04** | **·07** | **·16** | **·06** | **·18** | **Mean.** |
| | ·02–·48 | tr.–·69 | tr.–·58 | tr.–1·06 | tr.–·20 | tr.–·29 | tr.–·20 | tr.–·15 | tr.–·45 | tr.–·40 | tr.–·17 | tr.–1·02 | Range. |
| 10 | **·13** | **·15** | **·13** | **·10** | **·12** | **·12** | **·07** | **·06** | **·09** | **·06** | **·15** | **·14** | **Mean.** |
| | tr.–·60 | ·02–·47 | tr.–·51 | tr.–·49 | ·01–·55 | tr.–·28 | ·01–·25 | tr.–·20 | tr.–·34 | tr.–·31 | tr.–·77 | tr.–·53 | Range. |
| 11 | **·11** | **·17** | **·07** | **·06** | **·06** | **·03** | **·03** | **·03** | **·04** | **·04** | **·12** | **·12** | **Mean.** |
| | tr.–·46 | tr.–·68 | tr.–·38 | tr.–·33 | tr.–·28 | tr.–·17 | tr.–·10 | tr.–·26 | tr.–·15 | tr.–·12 | tr.–·47 | tr.–·41 | Range. |
| 12 | **·03** | **·04** | **·03** | **·08** | **·02** | **·04** | **·04** | **·01** | **·04** | **·02** | **·04** | **·04** | **Mean.** |
| | tr.–·50 | tr.–·14 | tr.–·07 | tr.–·42 | tr.–·05 | tr.–·36 | tr.–·19 | tr.–·05 | tr.–·13 | tr.–·06 | tr.–·17 | tr.–·08 | Range. |
| 13 | **·16** | **·04** | **·21** | **·18** | **·06** | **·11** | **·29** | **·11** | **·08** | **·15** | **·09** | **·24** | **Mean.** |
| | tr.–·81 | tr.–·10 | tr.–1·54 | tr.–1·05 | tr.–·24 | tr.–·52 | ·02–1·35 | tr.–·33 | 0·2–·46 | tr.–1·10 | tr.–·13 | ·04–1·15 | Range. |
| 14 | **·17** | **·17** | **·19** | **·19** | **·14** | **·09** | **·16** | **·48** | **·12** | **·29** | **·24** | **·25** | **Mean.** |
| | ·02–·95 | tr.–·54 | ·01–1·12 | ·01–·65 | tr.–·71 | ·01–·49 | tr.–·80 | tr.–2·74 | ·03–·49 | ·02–1·45 | ·03–1·05 | ·05–·60 | Range. |
| 15 | **1·21** | **·52** | **1·15** | **·85** | **·77** | **1·02** | **·85** | **1·02** | **1·52** | **·68** | **·94** | **1·45** | **Mean.** |
| | ·03–3·20 | tr.–1·76 | tr.–3·96 | ·02–3·12 | ·04–3·13 | ·01–3·24 | ·01–3·07 | ·04–4·01 | tr.–6·32 | ·02–2·17 | tr.–3·03 | ·04–3·07 | Range. |
| 16 | **1·24** | **·86** | **·60** | **1·11** | **1·00** | **·83** | **1·03** | **·94** | **·98** | **1·70** | **·99** | **1·25** | **Mean.** |
| | ·02–2·44 | tr.–3·98 | tr.–2·03 | tr.–5·40 | tr.–7·60 | tr.–3·11 | ·01–4·01 | ·01–2·52 | ·01–4·10 | ·01–9·92 | tr.–2·82 | tr.–4·35 | Range. |
| 17 | **1·05** | **·37** | **1·05** | **1·86** | **·63** | **1·52** | **1·24** | **1·70** | **1·76** | **1·44** | **1·27** | **1·50** | **Mean.** |
| | ·18–2·04 | ·12–·86 | ·05–4·42 | ·11–4·16 | ·19–1·76 | ·09–2·54 | ·18–2·33 | ·51–4·09 | ·18–3·47 | ·36–3·25 | ·17–3·43 | ·21–3·85 | Range. |
| 18 | **·85** | **1·24** | **1·14** | **1·11** | **·76** | **·76** | **·75** | **1·13** | **1·35** | **1·36** | **1·12** | **·52** | **Mean.** |
| | ·03–3·28 | tr.–5·98 | tr.–4·02 | ·05–3·21 | ·04–2·50 | tr.–2·06 | ·02–2·68 | ·03–4·70 | ·13–2·95 | ·08–3·74 | tr.–4·31 | ·03–1·52 | Range. |

tr. = trace.

## TABLE 12.

### *Mean Chlorine Content of Pastures. (Range Values included.)*

| Area. | January. | February. | March. | April. | May. | June. | July. | August. | Sept. | October. | Nov. | Dec. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **·33** | **·34** | **·26** | **·29** | **·18** | **·15** | **·12** | **·10** | **·17** | **·20** | **·33** | **·33** | **Mean.** |
| | ·13–1·02 | ·14– ·84 | ·10– ·64 | ·09–1·65 | ·07– ·65 | ·02– ·57 | ·01– ·48 | ·01– ·29 | ·03– ·58 | ·03– ·90 | ·09– ·77 | ·14– ·59 | Range. |
| 2 | **·59** | **·38** | **·38** | **·37** | **·31** | **·43** | **·36** | **·21** | **·42** | **·52** | **·41** | **·47** | **Mean.** |
| | ·10–1·80 | ·10–1·15 | ·09–1·23 | ·10– ·80 | ·09–2·08 | ·05–2·92 | ·06–1·39 | ·02–1·31 | ·01–1·97 | ·02–2·24 | ·08–1·24 | ·09– ·94 | Range. |
| 3 | **·32** | **·25** | **·20** | **·20** | **·17** | **·16** | **·12** | **·08** | **·18** | **·16** | **·32** | **·32** | **Mean.** |
| | ·12–1·10 | ·07– ·50 | ·09– ·59 | ·08– ·77 | ·04– ·42 | ·05– ·48 | ·02– ·49 | ·01– ·43 | ·02– ·52 | ·01– ·42 | ·07– ·70 | ·18– ·72 | Range. |
| 4 | **·32** | **·28** | **·30** | **·25** | **·31** | **·29** | **·27** | **·22** | **·36** | **·38** | **·47** | **·45** | **Mean.** |
| | ·14– ·60 | ·09– ·67 | ·07– ·94 | ·06– ·60 | ·07– ·76 | ·05–1·15 | ·04–1·33 | ·02– ·67 | ·07– ·93 | ·04–1·58 | ·12– ·86 | ·13–1·00 | Range. |
| 5 | **·47** | **·39** | **·26** | **·32** | **·33** | **·29** | **·24** | **·21** | **·30** | **·31** | **·40** | **·45** | **Mean.** |
| | ·13–1·62 | ·06–1·04 | ·05– ·68 | ·08– ·88 | ·06– ·74 | ·07–1·00 | ·03–1·02 | ·02– ·60 | ·04–1·28 | ·01–1·13 | ·07–1·61 | ·08–1·15 | Range. |
| 6 | **·37** | **·29** | **·19** | **·17** | **·14** | **·10** | **·09** | **·09** | **·12** | **·21** | **·26** | **·34** | **Mean.** |
| | ·11–1·62 | ·06– ·83 | ·04– ·32 | ·02– ·55 | ·04– ·36 | ·02– ·26 | ·01– ·23 | ·01– ·32 | ·02– ·56 | ·01– ·52 | ·06– ·60 | ·17– ·50 | Range. |
| 7 | **·33** | **·35** | **·22** | **·25** | **·18** | **·13** | **·08** | **·08** | **·16** | **·14** | **·33** | **·37** | **Mean.** |
| | ·13– ·64 | ·14– ·87 | ·06– ·45 | ·06 ·93 | ·03– ·63 | ·02– ·44 | ·02– ·27 | ·01– ·33 | ·02– ·64 | ·02– ·76 | ·13– ·56 | ·16– ·66 | Range. |
| 8 | **·32** | **·28** | **·26** | **·20** | **·14** | **·10** | **·08** | **·06** | **·12** | **·09** | **·21** | **·32** | **Mean.** |
| | ·10– ·56 | ·07– ·63 | ·07– ·90 | ·05– ·42 | ·07– ·35 | ·03– ·27 | ·02– ·15 | ·01– ·17 | ·02– ·43 | ·01– ·46 | ·03– ·43 | ·14– ·67 | Range. |
| 9 | **·42** | **·37** | **·32** | **·30** | **·22** | **·21** | **·15** | **·14** | **·24** | **·18** | **·31** | **·47** | **Mean.** |
| | ·14–1·08 | ·15–1·11 | ·10– ·99 | ·04– ·80 | ·04– ·69 | ·06– ·48 | ·06– ·50 | ·01– ·48 | ·02–1·70 | ·02– ·73 | ·07– ·75 | ·07–1·34 | Range. |
| 10 | **·48** | **·48** | **·40** | **·37** | **·31** | **·30** | **·23** | **·20** | **·22** | **·16** | **·41** | **·54** | **Mean.** |
| | ·08– ·79 | ·27– ·95 | ·04– ·80 | ·10– ·80 | ·04–1·24 | ·03–1·17 | ·03– ·15 | ·04– ·58 | ·04– ·62 | ·02– ·54 | ·06–1·11 | ·16–1·73 | Range. |
| 11 | **·38** | **·47** | **·34** | **·33** | **·23** | **·19** | **·18** | **·11** | **·12** | **·11** | **·38** | **·50** | **Mean.** |
| | ·12– ·81 | ·11–1·09 | ·06– ·82 | ·09– ·81 | ·07– ·80 | ·02– ·67 | ·02– ·57 | ·01– ·36 | ·01– ·38 | ·01– ·45 | ·04– ·68 | ·09– ·93 | Range. |
| 12 | **·23** | **·37** | **·27** | **·23** | **·23** | **·15** | **·17** | **·12** | **·14** | **·11** | **·16** | **·30** | **Mean.** |
| | ·03– ·48 | ·08– ·71 | ·07– ·67 | ·09– ·38 | ·05– ·50 | ·03– ·36 | ·06– ·40 | ·04– ·31 | ·02– ·33 | ·01– ·32 | ·02– ·47 | ·02– ·54 | Range. |
| 13 | **·39** | **·39** | **·45** | **·34** | **·38** | **·30** | **·33** | **·29** | **·12** | **·24** | **·48** | **·47** | **Mean.** |
| | ·14– ·63 | ·05– ·66 | ·13–1·35 | ·09–1·03 | ·05– ·83 | ·05– ·87 | ·04– ·81 | ·02– ·60 | ·02– ·22 | ·02– ·74 | ·17– ·96 | ·19–1·04 | Range. |
| 14 | **·45** | **·41** | **·25** | **·34** | **·32** | **·25** | **·27** | **·44** | **·24** | **·31** | **·39** | **·40** | **Mean.** |
| | ·11–1·05 | ·11– ·89 | ·07– ·40 | ·13– ·95 | ·08–1·08 | ·15– ·49 | ·04–1·02 | ·03–1·87 | ·08– ·88 | ·09– ·78 | ·15– ·68 | ·23– ·82 | Range. |
| 15 | **1·44** | **·40** | **1·06** | **·78** | **·56** | **·63** | **·74** | **·88** | **1·59** | **·74** | **·70** | **1·02** | **Mean.** |
| | ·26–3·80 | ·11–1·08 | ·16–2·82 | ·18–2·62 | ·15–1·84 | ·09–2·76 | ·09–2·66 | ·15–3·50 | ·07–9·02 | ·03–2·29 | ·07–2·05 | ·15–3·18 | Range. |
| 16 | **1·02** | **·43** | **·61** | **·71** | **·79** | **·65** | **·73** | **·59** | **·64** | **1·72** | **·67** | **·79** | **Mean.** |
| | ·15–2·49 | ·10–1·05 | ·07–1·89 | ·12–2·32 | ·13–5·96 | ·06–3·06 | ·08–2·39 | ·08–1·47 | ·01–1·47 | ·01–17·10 | ·14–2·40 | ·14–2·40 | Range. |
| 17 | **·97** | **·30** | **·82** | **1·36** | **·92** | **1·58** | **1·50** | **2·20** | **1·94** | **1·58** | **1·58** | **1·55** | **Mean.** |
| | ·22–2·60 | ·12– ·58 | ·12–1·86 | ·08–3·94 | ·16–5·06 | ·33–3·53 | ·43–3·67 | ·53–6·40 | ·36–4·48 | ·65–3·29 | ·09–5·30 | ·38–5·14 | Range. |
| 18 | **1·07** | **·82** | **·71** | **·89** | **·52** | **·66** | **·73** | **1·12** | **1·03** | **1·17** | **1·09** | **·46** | **Mean.** |
| | ·32–5·80 | ·06–3·95 | ·11–3·45 | ·06–3·49 | ·08–3·18 | ·13–2·15 | ·07–3·67 | ·13–4·19 | ·19–2·78 | ·20–4·12 | ·11–5·22 | ·17– ·97 | Range. |

### (4) POTASSIUM, SODIUM, AND CHLORINE.

The remarks made earlier in this discussion with reference to the trend of the phosphorus and protein averages of pastures in the course of the year may with equal justification be applied to the monthly averages for potassium and chlorine given in Tables 10 and 12, and to a lesser extent to the sodium figures given in Table 11.

Commencing with the averages for samples composed almost exclusively of grasses an inspection of the relevant tables reveals that potassium and chlorine reach their highest levels in the dry matter of the grasses in November, December or January corresponding with the months of highest rainfall and the period of most active growth. After January as the rainfall becomes less and the grasses tend to mature, the percentages of these constituents undergo a gradual decrease until the lowest levels for the year are reached during the dry and cold winter months—June, July and August, after which a gradual increase to the peak values mentioned above sets in. Sodium figures fluctuate somewhat irregularly from month to month but in general the tendency for lower values during the dry winter months as compared with the rainy season when values are higher is nevertheless apparent. Maximum average monthly figures for potassium in Areas 1 to 12 vary between 1·32 and 2·31 per cent., and for chlorine between 0·32 and 0·59 per cent. The corresponding minimum averages obtaining during winter range from 0·29 to 0·63 and 0·06 to 0·22 for potassium and chlorine, respectively.

The range values given above for the highest and lowest figures obtained for the pastures of Areas 1-12 serve to indicate that there are differences in the monthly averages of the pastures of individual areas in respect of potassium and chlorine. Thus the lowest average maximum figure for potassium occurs in the samples for December collected in Area 4, while Areas 3, 7 and 8 show the lowest average minimum values for potassium. On the other hand the pastures in Areas 6, 9, 10 and 11 are on the whole somewhat richer in potassium than any of the other areas from No. 1 to 12. Chlorine values, again, are highest both in regard to average minimum and maximum values in the pastures of Areas 2, 5, 9 and 10, while Areas 1, 3, 7 and 8 may be considered to be poorest in this constituent.

The grassland pastures are considered to be generally poor in sodium. In Areas 1, 3, 6, 7, 8 and 12 maximum values never exceed 0·08 per cent., while in the dry winter months they drop on an average as low as 0·01 per cent. A slight improvement is shown in the average sodium figures for Areas 9, 10 and 11 in the Parkland region of the Transvaal, while an appreciable increase in the figures for Areas 2 and 4, bordering on the coast of Natal, and Area 5 in the south-eastern part of the Cape is indicated. In Area 2 the average monthly figure drops only once (in August) below 0·10 per cent., ranging for the other months between 0·12 and 0·20 per cent. In Areas 4 and 5 the monthly averages vary between 0·10 and 0·20 per cent. and 0·14 and 0·25 per cent. respectively.

Passing from the all-grass or predominantly-grass pasture areas to the grass-bush or all-bush pastures of the Desert Shrub and Desert Succulent regions the percentage contents and monthly fluctuations of the three constituents under discussion undergo certain changes. To commence with potassium, although there is a tendency for this element to be lower during the months of least rainfall, it remains comparatively high throughout the year in the pastures of Areas 13 to 18. In fact, except for the months June, September and October in Area 13 potassium figures never drop below 1·00 per cent. and about 70 per cent. of figures range from 1·40 to 2·00 per cent. Sodium and chlorine figures fluctuate on the whole in a most irregular manner but never drop to the low levels indicated for some of the grassland areas. The pastures of Areas 13 and 14 do not differ much in sodium and chlorine content from those in Area 5. In the pastures of the remaining four areas, viz. Nos. 15, 16, 17 and 18 of the Desert Shrub and Desert Succulent regions both sodium and chlorine figures are on the whole exceptionally high. More than 60 per cent. of the average monthly sodium values range from 1·00 to 1·86 per cent., while only about 6·0 per cent. of the values drop below 0·60 per cent. sodium. Also, the great majority of chlorine figures exceed 0·70 per cent. and some of these rise to as high as 2·20 per cent. in the dry matter of the pastures.

The grasses have been shown to be on the whole extremely poor in sodium throughout the year, while chlorine values also are somewhat low, especially during the dry winter months. The higher values obtained for both elements in the pastures of Areas 15, 16, 17 and 18 must therefore be ascribed to the shrubs and other herbaceous plants present in the samples from these areas. However, that shrubs or bushes are not always rich in sodium and chlorine is soon realised from an inspection of the tables in the appendix giving the analyses of individual samples from Areas 12, 13, and 14 where many " bush " and " bush and grass " samples were collected.

From remarks made in the oft quoted bulletin by Mitchell and McClure (*loc. cit*) it appears that 25·0 grams of potassium daily is more than enough to carry calves through growth and gestation. Also, in the light of work done at this Institute [Theiler *et al* (1927), du Toit *et al* (1934)] it would seem that 32·0 grams of potassium is adequate for the production of 2 gallons of milk daily, although 18·0 grams are secreted in the milk. The requirements of growing cattle for sodium and chlorine are considered very low, about 1·5 grams of sodium and less than 5·0 grams of chlorine per day being taken to be sufficient. Finally, it was provisionally suggested that 14·0 grams of chlorine was sufficient to provide for the daily secretion of 2 gallons of milk and that this amount would also be enough for growth and gestation. 11·0 Grams of sodium apparently sufficed for the normal production of the same amount of milk per day.

Assuming again an average dry matter consumption of 16 lb. per day it would mean that the dry matter of the ration of a cow producing 2 gallons of milk per day should contain 0·45 per cent. potassium and that of a growing bovine 0·34 per cent. Reference to Table 10 showing the average potassium content of South African pastures indicates that the probability of a potassium deficiency in animals grazing on these pastures is indeed remote.

## TABLE 13.

## MEAN CRUDE FIBRE CONTENT OF PASTURES (RANGE VALUES INCLUDED).

| Area. | Jan. | Feb. | March. | April. | May. | June. | July. | August. | Sept. | Oct. | Nov. | Dec. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **36·5** | **37·6** | **36·2** | **36·0** | **35·3** | **36·8** | **37·5** | **38·1** | **36·9** | **36·6** | **35·5** | **36·4** | **Mean.** |
| | 27·6– | 32·3– | 31·5– | 26·8– | 28·9– | 28·5– | 31·3– | 28·8– | 30·4– | 29·0– | 27·8– | 29·4– | Range. |
| | 42·8 | 43·5 | 41·3 | 48·7 | 44·5 | 42·6 | 43·7 | 44·5 | 46·5 | 44·0 | 43·0 | 43·1 | |
| 2 | **37·4** | **38·0** | **37·1** | **36·8** | **36·8** | **37·0** | **36·9** | **38·9** | **37·3** | **36·6** | **36·9** | **36·1** | **Mean.** |
| | 30·4– | 26·0– | 31·5– | 31·1– | 31·9– | 29·9– | 25·2– | 31·0– | 30·3– | 28·7– | 28·4– | 27·7– | Rang. |
| | 45·3 | 43·3 | 42·5 | 44·5 | 44·0 | 42·7 | 41·5 | 46·8 | 44·1 | 45·4 | 42·9 | 41·2 | |
| 3 | **36·6** | **36·2** | **35·7** | **34·8** | **35·1** | **35·9** | **36·4** | **36·6** | **35·9** | **35·3** | **34·8** | **35·0** | **Mean.** |
| | 32·9– | 31·4– | 27·9– | 26·4– | 30·4– | 30·7– | 30·5– | 31·6– | 30·3– | 27·8– | 30·3– | 29·5– | Range. |
| | 40·3 | 45·1 | 42·0 | 40·2 | 40·0 | 40·7 | 41·7 | 43·8 | 40·8 | 40·5 | 40·3 | 40·9 | |
| 4 | **35·4** | **36·5** | **37·4** | **35·0** | **37·4** | **36·3** | **36·1** | **37·4** | **36·4** | **36·4** | **35·5** | **36·0** | **Mean.** |
| | 32·7– | 32·6– | 32·6– | 30·2– | 32·9– | 31·4– | 31·9– | 33·4– | 30·6– | 32·3– | 31·5– | 32·7– | Range. |
| | 39·6 | 41·4 | 44·1 | 40·8 | 43·1 | 41·4 | 39·8 | 43·3 | 41·6 | 41·5 | 39·8 | 38·9 | |
| 5 | **34·7** | **33·6** | **34·6** | **33·1** | **34·9** | **34·4** | **35·2** | **35·2** | **34·9** | **33·5** | **34·2** | **33·2** | **Mean.** |
| | 27·8– | 24·8– | 27·5– | 20·6– | 29·3– | 26·7– | 27·9– | 26·4– | 30·7– | 25·5– | 25·5– | 23·6– | Range. |
| | 40·9 | 43·2 | 40·9 | 39·6 | 41·3 | 39·5 | 40·1 | 40·7 | 46·2 | 40·5 | 42·7 | 46·0 | |
| 6 | **34·1** | **34·6** | **35·3** | **33·7** | **35·5** | **35·0** | **35·7** | **35·7** | **34·6** | **34·0** | **33·8** | **32·8** | **Mean.** |
| | 24·8– | 25·2– | 31·3– | 28·5– | 30·0– | 29·7– | 31·9– | 33·1– | 29·5– | 21·4– | 21·4– | 22·7– | Range. |
| | 43·5 | 41·3 | 41·6 | 38·8 | 40·6 | 43·0 | 41·3 | 41·8 | 39·8 | 40·4 | 37·5 | 37·5 | |
| 7 | **36·5** | **35·1** | **35·9** | **34·5** | **35·7** | **37·2** | **37·6** | **37·9** | **37·4** | **36·1** | **34·4** | **35·0** | **Mean.** |
| | 29·3– | 31·2– | 27·8– | 29·3– | 30·2– | 32·3– | 31·4– | 31·8– | 28·2– | 29·2– | 27·4– | 20·7– | Range. |
| | 43·2 | 39·8 | 42·5 | 39·8 | 42·1 | 46·0 | 41·9 | 44·7 | 43·5 | 43·8 | 41·8 | 42·0 | |
| 8 | **35·6** | **34·8** | **34·9** | **34·6** | **34·8** | **36·0** | **36·6** | **35·9** | **34·5** | **34·2** | **35·9** | **33·9** | **Mean.** |
| | 30·0– | 30·2– | 30·4– | 29·3– | 28·6– | 31·4– | 30·7– | 31·7– | 31·3– | 31·4– | 29·5– | 26·0– | Range. |
| | 41·9 | 40·0 | 40·1 | 40·3 | 42·0 | 42·7 | 41·4 | 41·2 | 38·2 | 42·7 | 42·1 | 42·8 | |
| 9 | **37·0** | **35·0** | **35·2** | **35·9** | **35·9** | **35·9** | **37·4** | **37·9** | **37·0** | **34·7** | **34·0** | **34·4** | **Mean.** |
| | 30·7– | 24·5– | 28·8– | 30·1– | 26·5– | 29·1– | 28·3– | 31·8– | 29·3– | 21·2– | 23·2– | 27·7– | Range. |
| | 42·3 | 40·4 | 42·5 | 42·2 | 41·0 | 42·2 | 45·5 | 45·5 | 43·2 | 41·2 | 40·3 | 40·1 | |

TABLE 13 (*continued*).

| Area. | Jan. | Feb. | March. | April. | May. | June. | July. | August. | Sept. | Oct. | Nov. | Dec. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | **36·1** | **35·7** | **35·4** | **34·6** | **35·7** | **36·6** | **36·5** | **37·8** | **38·5** | **37·1** | **33·2** | **34·8** | **Mean.** |
| | 27·4–41·4 | 21·8–43·3 | 28·9–43·6 | 26·3–40·7 | 29·4–41·3 | 28·2–45·1 | 29·1–51·6 | 31·2–43·7 | 32·9–44·5 | 23·3–44·1 | 22·7–40·3 | 24·0–41·9 | Range. |
| 11 | **34·0** | **34·6** | **35·5** | **34·1** | **34·5** | **35·9** | **36·4** | **37·1** | **36·2** | **35·2** | **32·8** | **33·1** | **Mean.** |
| | 27·2–41·5 | 29·3–39·3 | 27·6–40·3 | 25·5–40·3 | 26·6–40·6 | 28·4–44·2 | 27·6–42·8 | 30·2–43·5 | 35·0–43·4 | 21·2–41·4 | 24·0–40·9 | 28·3–42·5 | Range. |
| 12 | **35·3** | **34·1** | **36·0** | **34·3** | **36·8** | **36·0** | **35·7** | **37·5** | **36·3** | **36·3** | **35·0** | **34·1** | **Mean.** |
| | 25·2–44·1 | 23·8–39·6 | 25·2–43·2 | 26·9–38·9 | 32·3–40·8 | 23·9–43·2 | 27·4–42·0 | 32·5–41·0 | 31·5–39·8 | 28·8–40·9 | 25·6–39·2 | 26·5–42·2 | Range. |
| 13 | **32·8** | **34·7** | **33·8** | **32·4** | **32·3** | **33·9** | **32·0** | **34·5** | **35·6** | **32·2** | **30·8** | **32·6** | **Mean.** |
| | 25·6–42·2 | 32·0–37·0 | 30·1–36·6 | 24·1–38·6 | 23·6–39·2 | 30·3–38·7 | 25·1–38·3 | 20·2–40·4 | 28·8–38·7 | 25·1–40·8 | 24·3–37·2 | 28·7–38·5 | Range. |
| 14 | **36·5** | **33·3** | **34·9** | **30·9** | **34·9** | **32·3** | **35·4** | **34·2** | **34·9** | **32·9** | **34·5** | **33·6** | **Mean.** |
| | 29·4–44·2 | 27·6–37·7 | 25·5–43·6 | 24·4–36·2 | 28·8–39·7 | •28·3–37·3 | 24·6–43·9 | 28·9–42·1 | 24·5–44·3 | 26·2–44·1 | 29·4–43·9 | 28·1–37·8 | Range. |
| 15 | **32·3** | **35·7** | **32·2** | **32·4** | **36·6** | **31·8** | **34·4** | **33·0** | **28·7** | **34·4** | **34·7** | **29·8** | **Mean.** |
| | 21·2–42·8 | 29·0–43·8 | 23·3–40·2 | 22·1–39·6 | 27·1–44·7 | 19·5–39·6 | 21·0–46·6 | 23·9–41·4 | 18·5–38·0 | 28·5–45·7 | 22·3–48·2 | 24·3–36·6 | Range. |
| 16 | **33·7** | **35·9** | **37·8** | **32·5** | **33·4** | **32·1** | **32·0** | **31·4** | **32·6** | **32·8** | **31·5** | **34·3** | **Mean.** |
| | 27·0–40·4 | 24·6–44·3 | 26·5–45·9 | 23·8–40·5 | 21·2–41·0 | 25·3–41·0 | 22·6–40·1 | 24·8–41·5 | 23·4–42·8 | 20·1–42·0 | 24·5–36·1 | 24·6–42·6 | Range. |
| 17 | **36·5** | **39·3** | **37·7** | **34·2** | **37·3** | **33·0** | **35·1** | **29·8** | **33·6** | **34·1** | **33·3** | **35·3** | **Mean.** |
| | 30·8–51·8 | 25·5–48·2 | 32·9–43·3 | 21·6–49·0 | 23·8–43·3 | 21·7–43·8 | 31·2–39·1 | 24·0–39·7 | 27·0–39·7 | 26·4–44·4 | 26·1–42·1 | 28·4–39·9 | Range. |
| 18 | **37·9** | **35·2** | **37·6** | **34·1** | **36·0** | **33·9** | **35·4** | **33·3** | **31·8** | **33·6** | **35·9** | **35·4** | **Mean.** |
| | 32·6–41·6 | 24·5–42·2 | 26·3–42·9 | 26·0–42·6 | 31·2–40·0 | 24·6–42·4 | 30·2–42·4 | 25·1–44·6 | 25·7–36·8 | 27·9–40·3 | 27·6–41·0 | 30·5–43·5 | Range. |

Similarly, the necessary percentages of sodium and chlorine in the ration of growing cattle should be 0·02 and 0·07 per cent., and in that of cows secreting 2 gallons of milk daily 0·15 and 0·19 per cent., respectively. An inspection of the relevant tables describing the average percentages of sodium and chlorine in our pastures reveals that the requirements of growing cattle for chlorine will at all times be met by 16 lb. of pasturage, while in some areas and then only for a few months during the dry season the chlorine intake on veld alone will not be sufficient for the production of 2 gallons of milk. On the whole sufficient sodium will be ingested with 16 lb. of pasturage (dry matter basis) for the requirements of growing cattle. The sodium content of especially the grassland pastures are extremely low (0·01 per cent. of the dry matter) during winter, lower, therefore, than the necessary percentage for normal growth. But, since growth is in any case greatly retarded by a deficiency of other factors (phosphorus and protein) the deficiency of sodium during the said period may not in itself be considered serious. On the other hand, if the estimated sodium requirement in terms of a percentage of the ration of a cow producing 2 gallons of milk daily is considered in relation to the sodium figures given in Table 11 a serious sodium deficiency is seen to occur in the pastures of the Grassland Areas 1, 3, 6, 7, 8 and 12 throughout the whole year and in those of Areas 9, 10 and 11 during winter. In all other areas the pastures contain sufficient sodium for the requirements of lactating animals.

### (5) CRUDE FIBRE AND SOLUBLE ASH.

The percentage content and variation of the individual constituents of the ash of the pasture samples from month to month discussed in the preceding pages should naturally be reflected in the figures for the total soluble ash given in Table 14. Individual constituents present in the greatest amount and subject to the greatest fluctuations will largely determine the content and variation in the average values for soluble ash. That this is so is evident from a study of the average percentages for individual constituents and soluble ash given in Tables 2 and 3, Tables 8 to 12, and Table 14, respectively.

Average monthly figures for crude fibre, the last of the list of constituents determined, are presented in Table 13. A glance at these figures does not reveal marked differences in the crude fibre content of the pastures in one area from another, nor in the monthly figures of any one area, the range of variation for all the months of the year and all the areas being approximately 30·0 to 38·0 per cent. Closer examination of the data, however, justifies reference to a few minor differentiating features in the crude fibre content of pastures in the course of the year and in the various areas. In the first place, though fluctuating most irregularly reaching in percentage amount during some months the higher limit indicated above for the pastures of the country as a whole, the crude fibre figures for the areas in the Desert Shrub and Desert Succulent regions are somewhat lower than those for areas in the Grassland regions. Dividing the 18 areas into three groups, viz. Nos. 1-12 (grass), Nos. 13-16 (desert shrub), and

## TABLE 14.

## MEAN SOLUBLE ASH CONTENT OF PASTURES (RANGE VALUES INCLUDED).

| Area. | Jan. | Feb. | March. | April. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **3·11** | **2·91** | **2·87** | **2·82** | **2·20** | **1·97** | **1·70** | **1·69** | **1·93** | **2·26** | **3·05** | **3·16** | **Mean.** |
| | 1·94–<br>9·68 | 1·82–<br>4·48 | 1·92–<br>8·83 | 1·62–<br>9·28 | 1·32–<br>4·08 | 0·90–<br>4·59 | 0·94–<br>3·33 | 0·93–<br>3·64 | 1·00–<br>3·46 | 0·95–<br>4·78 | 1·60–<br>6·10 | 1·94–<br>5·36 | Range. |
| 2 | **3·95** | **3·24** | **2·95** | **2·98** | **2·66** | **2·79** | **2·87** | **1·91** | **2·71** | **3·42** | **3·07** | **3·61** | **Mean.** |
| | 1·40–<br>9·21 | 1·74–<br>8·68 | 1·11–<br>6·07 | 1·24–<br>7·72 | 1·42–<br>7·64 | 1·16–<br>8·62 | 1·19–<br>8·00 | 0·92–<br>6·40 | 0·94–<br>8·56 | 0·78–<br>8·60 | 1·25–<br>8·36 | 1·83–<br>7·02 | Range. |
| 3 | **2·97** | **2·69** | **2·41** | **2·25** | **1·96** | **1·98** | **1·66** | **1·54** | **1·96** | **2·01** | **3·03** | **3·05** | **Mean.** |
| | 1·71–<br>5·10 | 1·59–<br>4·39 | 1·44–<br>3·91 | 1·46–<br>3·91 | 1·39–<br>3·08 | 1·21–<br>3·88 | 1·15–<br>3·55 | 1·02–<br>3·55 | 1·09–<br>4·30 | 0·89–<br>3·86 | 1·78–<br>4·90 | 1·88–<br>6·42 | Range. |
| 4 | **2·55** | **2·47** | **2·30** | **2·40** | **2·35** | **2·19** | **2·12** | **1·88** | **2·36** | **2·52** | **2·85** | **3·08** | **Mean.** |
| | 1·66–<br>3·93 | 0·27–<br>4·36 | 1·31–<br>4·48 | 1·40–<br>4·94 | 1·27–<br>4·37 | 1·54–<br>4·56 | 1·37–<br>6·08 | 0·89–<br>3·93 | 0·97–<br>7·04 | 1·07–<br>6·83 | 1·59–<br>4·85 | 1·70–<br>4·48 | Range. |
| 5 | **3·85** | **3·78** | **2·79** | **3·41** | **3·20** | **2·92** | **2·55** | **2·55** | **2·77** | **3·03** | **3·59** | **3·96** | **Mean.** |
| | 1·45–<br>10·03 | 1·77–<br>8·72 | 1·31–<br>5·25 | 1·72–<br>9·78 | 1·70–<br>7·28 | 1·35–<br>9·28 | 1·10–<br>7·20 | 1·21–<br>7·19 | 1·05–<br>10·18 | 1·08–<br>9·62 | 2·42–<br>9·72 | 1·93–<br>8·42 | Range. |
| 6 | **3·72** | **3·09** | **2·86** | **2·43** | **2·29** | **1·98** | **1·69** | **1·89** | **2·04** | **2·58** | **2·86** | **4·27** | **Mean.** |
| | 2·23–<br>8·66 | 1·34–<br>10·2 | 1·79<br>6·40 | 1·60–<br>5·02 | 1·10–<br>5·10 | 1·11–<br>3·83 | 1·13–<br>2·58 | 1·18–<br>3·99 | 1·17–<br>4·01 | 1·18–<br>6·04 | 1·64–<br>4·98 | 2·13–<br>11·7 | Range. |
| 7 | **3·32** | **3·22** | **2·68** | **2·53** | **2·05** | **1·88** | **1·65** | **1·69** | **1·87** | **2·06** | **3·19** | **3·57** | **Mean.** |
| | 2·04–<br>6·36 | 2·10–<br>8·80 | 1·71–<br>4·71 | 1·50–<br>6·72 | 1·31–<br>4·37 | 0·63–<br>3·67 | 1·19–<br>2·62 | 1·10–<br>3·17 | 1·06–<br>3·67 | 1·14–<br>4·24 | 1·56–<br>5·48 | 2·32–<br>5·40 | Range. |
| 8 | **3·30** | **3·02** | **2·82** | **2·52** | **2·13** | **2·00** | **1·85** | **1·76** | **1·96** | **2·06** | **2·52** | **3·58** | **Mean.** |
| | 1·51–<br>5·49 | 1·60–<br>4·82 | 1·65–<br>4·95 | 1·37–<br>3·70 | 1·53–<br>5·24 | 1·24–<br>3·73 | 1·30–<br>3·03 | 1·01–<br>3·28 | 1·27–<br>3·72 | 1·23–<br>3·85 | 1·47–<br>3·57 | 2·30–<br>5·94 | Range. |
| 9 | **3·73** | **3·68** | **3·91** | **3·05** | **2·76** | **3·24** | **2·26** | **2·00** | **2·76** | **2·51** | **3·65** | **4·35** | **Mean.** |
| | 1·38–<br>6·86 | 1·62–<br>1·11 | 1·70–<br>10·15 | 1·57–<br>5·04 | 1·50–<br>7·58 | 1·00–<br>10·1 | 1·25–<br>4·68 | 0·94–<br>3·34 | 1·01–<br>17·1 | 1·12–<br>5·16 | 1·21–<br>10·6 | 2·13–<br>10·4 | Range. |

TABLE 14 (*continued*).

| Area. | Jan. | Feb. | March. | April. | May. | June. | July. | August. | Sept. | Oct. | Nov. | Dec. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | **4·45** | **4·58** | **4·33** | **3·96** | **3·50** | **3·20** | **3·00** | **2·83** | **2·56** | **2·95** | **4·80** | **5·32** | **Mean.** |
| | 1·40–8·02 | 2·15–8·08 | 1·85–6·15 | 1·56–11·08 | 1·33–6·74 | 0·98–5·66 | 1·07–6·06 | 1·20–6·45 | 1·29–4·83 | 1·12–8·54 | 1·30–9·50 | 1·75–9·03 | Range. |
| 11 | **4·81** | **4·45** | **3·47** | **3·08** | **2·77** | **2·56** | **2·73** | **2·38** | **2·36** | **2·46** | **4·33** | **5·55** | **Mean.** |
| | 2·47–8·06 | 1·98–10·0 | 1·95–9·85 | 1·82–8·10 | 1·42–5·40 | 1·28–5·60 | 1·27–6·18 | 1·16–7·30 | 1·14–6·03 | 1·25–7·70 | 1·38–9·06 | 2·40–8·38 | Range. |
| 12 | **4·13** | **5·01** | **4·16** | **4·27** | **3·61** | **3·07** | **3·86** | **2·65** | **2·74** | **2·75** | **3·37** | **4·84** | **Mean.** |
| | 1·32–11·30 | 2·65–8·58 | 1·66–10·3 | 1·45–8·05 | 1·29–6·08 | 1·12–8·82 | 1·00–11·3 | 0·98–6·46 | 1·32–4·40 | 1·44–5·93 | 0·95–6·62 | 0·78–10·54 | Range. |
| 13 | **6·58** | **4·54** | **4·36** | **4·71** | **5·62** | **3·65** | **4·88** | **4·54** | **2·88** | **3·58** | **4·60** | **4·91** | **Mean.** |
| | 1·90–15·52 | 2·20–5·58 | 1·77–9·28 | 2·32–10·00 | 1·29–12·22 | 1·18–5·96 | 2·27–8·38 | 1·59–7·73 | 1·42–4·84 | 1·06–7·52 | 2·09–8·61 | 2·58–8·61 | Range. |
| 14 | **5·08** | **4·77** | **5·28** | **5·70** | **4·98** | **4·92** | **4·60** | **5·11** | **4·90** | **5·57** | **5·23** | **4·87** | **Mean.** |
| | 2·58–8·66 | 2·37–9·00 | 2·42–10·55 | 2·48–8·88 | 2·23–8·96 | 2·19–7·44 | 2·18–8·15 | 2·07–12·20 | 2·00–8·70 | 2·30–10·63 | 2·71–7·36 | 3·20–5·71 | Range. |
| 15 | **9·10** | **5·46** | **8·20** | **7·55** | **6·30** | **6·96** | **7·46** | **7·65** | **10·04** | **6·41** | **7·24** | **9·37** | **Mean.** |
| | 3·08–15·54 | 2·34–8·90 | 2·46–15·83 | 3·82–14·95 | 2·42–13·98 | 1·97–14·18 | 2·97–16·30 | 3·84–17·90 | 1·25–27·20 | 1·82–13·15 | 1·84–15·10 | 2·53–14·22 | Range. |
| 16 | **8·80** | **6·71** | **6·42** | **8·23** | **8·16** | **7·17** | **8·11** | **7·90** | **8·33** | **9·46** | **7·69** | **8·53** | **Mean.** |
| | 2·46–14·60 | 2·81–17·35 | 2·55–12·43 | 2·05–21·44 | 2·34–30·15 | 1·83–14·48 | 2·62–12·28 | 2·36–16·50 | 1·76–35·40 | 1·76–35·40 | 3·58–14·04 | 1·49–18·78 | Range. |
| 17 | **7·91** | **4·28** | **6·27** | **9·83** | **6·94** | **9·52** | **9·21** | **11·05** | **11·30** | **9·91** | **8·67** | **8·87** | **Mean.** |
| | 2·87–12·27 | 2·05–7·00 | 1·23–16·10 | 2·19–16·30 | 3·80–18·48 | 5·17–15·27 | 6·00–13·45 | 6·81–19·80 | 3·65–19·30 | 6·33–15·18 | 4·02–14·90 | 3·43–16·78 | Range. |
| 18 | **6·97** | **8·36** | **8·97** | **7·63** | **6·45** | **6·78** | **7·33** | **8·28** | **9·29** | **9·00** | **7·77** | **5·99** | **Mean.** |
| | 1·33–17·65 | 3·95–24·00 | 2·83–18·65 | 2·03–17·30 | 1·89–13·25 | 2·19–12·00 | 3·37–16·67 | 1·98–18·75 | 4·34–18·90 | 3·13–16·60 | 2·33–18·36 | 1·93–10·07 | Range. |

No. 17 and 18 (desert succulents and desert grass), and calculating monthly mean values for each group from the averages in Table 13 results in annual ranges of variation of 34·6-37·2, 32·1-34·9, and 31·6-37·2 per cent. crude fibre for the three groups, respectively. The calculated mean values given in Table 15 show the irregular fluctuations previously referred to. However, in the case of the Desert Succulent region values tend to be lower during the winter than during the summer months. Reference to Tables 2 and 3 reveals that both phosphorus and protein values, especially in Area 17, are higher during winter than in summer, indicating herbage at a younger stage of growth for the winter months, and this circumstance again being responsible for the lower crude fibre values as indicated above.

The mean figures for crude fibre for the grass pastures of Areas 1-12 given in Table 15 and presented graphically in Figure 6 together with the corresponding mean protein curve to be referred to anon show a fairly well-defined seasonal tendency which applies more or less to each of the individual grassland areas. The mean figure is highest in August and then falls gradually to a minimum value for the year in November and December. After being at a slightly higher level during January, February, and March the mean value drops to a second minimum in April after which it steadily rises to the maximum in August referred to above. This curve representing the mean crude fibre content of grass pastures from January to December indicates in general that in winter when the veld, as has been shown, is poorest in the essential nutrients, phosphorus and protein, it is at the same time more fibrous and consequently less palatable than in the summer when the percentage content of the nutrients mentioned are at their highest levels for the year. Furthermore, the curve obtained from the analyses of samples collected by following animals is considered to be a fairly true reflection of the manner in which one would anticipate how the grazing animal would select its food from the available pasturage as the purely physical condition thereof changes in the course of the year. In August practically all grasses are brown and dried out; the animal has no option and has to select its food from such pastures. The ingestion of pasture of a fibrous nature is inevitable. From September the temperature rises, rains begin to fall in light showers (c.f. Table 1) and a small amount of green succulent growth becomes available to the animal, not, however, sufficient to fulfil its requirements; it still has to graze on the old growth as well. The amount of new growth in the meantime increases with increasing rainfall until in November or December the animal will be grazing on green pasture only. A gradual decrease in the fibre content of the ingested food from August to December may thus be expected on natural pastures which have not been burnt earlier in the year. Except where a scientific system of pasture management is practised or where the pasture is overgrazed, the grazing animal will not be able to prevent the fast growing grasses from reaching the seeding stage of growth during the rapidly growing season of the year. While the pasture is still in a green and succulent state the animal will graze during January, February, and March freely on these flowering and seeding grasses which nevertheless contain a higher percentage of fibrous material than was the case in November and December. In

## TABLE 15.

| | Jan. | Feb. | March. | April. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Grasslands**...................... | 35·8 | 35·6 | 35·8 | 34·8 | 35·7 | 36·1 | 36·6 | 37·2 | 36·3 | 35·5 | 34·7 | 34·6 |
| **Desert shrub**..................... | 33·8 | 34·9 | 34·7 | 32·1 | 34·2 | 32·5 | 33·5 | 33·3 | 33·0 | 33·1 | 32·9 | 32·6 |
| **Desert succulent**.................. | 37·2 | 37·2 | 37·2 | 34·2 | 36·7 | 33·5 | 35·3 | 31·6 | 32·7 | 33·9 | 34·6 | 35·4 |

## TABLE 16.

*Mean Ca and P Contents and Ca : P Ratios of Pastures.*

| | Areas 1, 2, 3, 4, 7 and 8. | | | Areas 5 and 6. | | | Area 10. | | | Areas 9, 11 and 12. | | | Areas 13 and 14. | | | Areas 15 and 16. | | | Areas 17 and 18. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ca. | P. | Ca/P. | Ca. | P. | Ca/P. | Ca. | P. | Ca/P. | Ca. | P. | Ca/P. | Ca. | P. | Ca/P. | Ca. | P. | Ca/P. | Ca. | P. | Ca/P. |
| January........... | ·28 | ·124 | 2·26 | ·33 | ·155 | 2·13 | ·40 | ·161 | 2·48 | ·40 | ·141 | 2·84 | ·55 | ·217 | 2·53 | ·83 | ·155 | 5·36 | ·95 | ·102 | 9·31 |
| February.......... | ·28 | ·112 | 2·50 | ·35 | ·148 | 2·36 | ·44 | ·157 | 2·80 | ·44 | ·136 | 3·23 | ·47 | ·187 | 2·51 | ·82 | ·144 | 5·70 | ·89 | ·109 | 8·17 |
| March............. | ·30 | ·104 | 2·88 | ·34 | ·128 | 2·66 | ·49 | ·144 | 3·40 | ·51 | ·118 | 4·32 | ·54 | ·174 | 3·10 | ·84 | ·160 | 5·25 | 1·03 | ·100 | 10·30 |
| April............. | ·30 | ·102 | 2·94 | ·37 | ·130 | 2·85 | ·50 | ·126 | 3·97 | ·48 | ·108 | 4·44 | ·73 | ·196 | 3·72 | ·92 | ·155 | 5·94 | 1·06 | ·105 | 10·10 |
| May............... | ·31 | ·083 | 3·73 | ·36 | ·119 | 3·02 | ·46 | ·126 | 3·65 | ·49 | ·083 | 5·90 | ·76 | ·164 | 4·63 | ·87 | ·150 | 5·80 | ·99 | ·132 | 7·50 |
| June.............. | ·30 | ·076 | 3·95 | ·34 | ·110 | 3·09 | ·49 | ·122 | 4·02 | ·53 | ·077 | 6·88 | ·66 | ·146 | 4·52 | ·90 | ·143 | 6·29 | ·98 | ·131 | 7·48 |
| July.............. | ·31 | ·072 | 4·30 | ·34 | ·098 | 3·47 | ·50 | ·111 | 4·51 | ·51 | ·077 | 6·62 | ·74 | ·169 | 4·38 | ·91 | ·169 | 5·38 | 1·12 | ·132 | 8·48 |
| August............ | ·28 | ·066 | 4·24 | ·36 | ·094 | 3·83 | ·54 | ·106 | 5·09 | ·44 | ·060 | 7·33 | ·63 | ·153 | 4·12 | 1·02 | ·168 | 6·07 | 1·20 | ·148 | 8·10 |
| September......... | ·29 | ·078 | 3·72 | ·34 | ·099 | 3·44 | ·43 | ·080 | 5·38 | ·48 | ·055 | 8·72 | ·61 | ·128 | 4·77 | ·98 | ·158 | 6·20 | 1·10 | ·147 | 7·48 |
| October........... | ·27 | ·094 | 2·87 | ·35 | ·130 | 2·69 | ·43 | ·093 | 4·63 | ·41 | ·088 | 4·66 | ·62 | ·152 | 4·08 | ·89 | ·143 | 6·22 | 1·10 | ·135 | 8·15 |
| November.......... | ·27 | ·123 | 2·19 | ·34 | ·139 | 2·45 | ·54 | ·189 | 2·86 | ·46 | ·115 | 4·00 | ·61 | ·180 | 3·39 | ·85 | ·144 | 5·90 | 1·06 | ·092 | 11·52 |
| December.......... | ·29 | ·131 | 2·21 | ·36 | ·185 | 1·94 | ·49 | ·183 | 2·68 | ·52 | ·143 | 3·64 | ·43 | ·191 | 2·25 | ·84 | ·158 | 5·32 | ·90 | ·114 | 7·90 |

April the grasses begin to dry out, some becoming hard and fibrous, with the result that the animal is bound to be more selective in its choice of food than during the previous months; long fibrous stems with partially dry seedheads will be avoided and for a short time the material consumed may be expected to be less fibrous than that ingested in say, January. However, with practically no more rain falling and with the onset of the cold winter months the grasses turn brown and become dry, so that the animal is in an ever increasing degree dependent on dry, mature pasturage from May to August, a circumstance which will naturally result in an increase in the fibre content of the food consumed during the said period. That the curve (Fig. 6) representing the changes in the fibre content of the samples collected in the grass areas (Nos. 1-12) conforms in general to the known seasonal chemical and physical changes of grasses but more so to the highly probable method by which the animal will select its food from the available pasturage as outlined above is taken as a strong indication that the samples collected for this mineral survey are representative of the food actually selected by animals under grazing conditions on natural veld.

In connection with the relatively small variation in the crude fibre figures in the course of the year, for instance 34·6 per cent. for December to 37·2 per cent.for August it should be pointed out that " whilst . . . the actual figure for crude fibre may be of a similar magnitude in two different herbage samples, the changes taking place in the structural material of plants with age will result in decreased digestibility of the crude fibre " (Louw, 1938). In terms of digestibility crude fibre the seasonal fluctuations for this constituent in the pastures would thus be much greater than those indicated by the figures in Table 15.

### (6) INTERRELATIONSHIP OF SOME CONSTITUENTS.

In view of what has been said when discussing the results it may be expected that a fairly close correlation exists among some of the constitutens determined, especially in the case of samples composed exclusively or predominantly of grasses. The following correlation coefficients calculated from the average monthly figures for the samples from three of the eighteen areas are representative of grass and of desert shrub veld:—

*Correlation Coefficients.*

| | *Grass* | *Desert Shrub.* | |
|---|---|---|---|
| | *Area* 1. | *Area* 14. | *Area* 16. |
| P and protein ... ... | + ·97 | + ·66 | + ·32 |
| P and Cl ... ... ... ... | + ·92 | + ·65 | - ·30 |
| P and K ... ... ... ... | + ·97 | + ·81 | + ·12 |
| Protein and K ... ... | + ·92 | + ·76 | + ·55 |
| Protein and Cl ... ... | + ·92 | + ·35 | - ·29 |
| K and Cl ... ... ... ... | + ·98 | + ·43 | - ·09 |
| Na and Cl ... ... ... | + ·69 | + ·59 | + ·88 |

These coefficients show for Area 1 (grassveld) almost perfect correlation for the constituents as tabulated, with the exception of sodium which, however, still shows quite a significant correlation with chlorine. On the other hand, in Area 16 where samples composed of bushes predominated the only close correlation is that between sodium and chlorine, all other correlations being insignificant. Area 14 where the samples analysed may be divided into about equal numbers of grass samples and samples composed of bushes takes an intermediate position with regard to the correlation coefficients of the constituents. The coefficients range, in fact, from an insignificant (K and Cl) to a fairly close correlation (P and K). The inverse relationship between crude fibre and crude protein referred to in a previous publication (du Toit *et al*/1935/) has been statistically established by the calculation of the correlation coefficient of the mean monthly figures for these constituents in the grassveld region as a whole (Areas 1 to 12). These mean values are presented graphically in Fig. 6 and the coefficient calculated, viz. $-0{\cdot}77$ shows a fairly close negative correlation.

Since it plays under certain circumstances such an important rôle in the mineral nutrition of farm animals it will be of interest to devote some space to a consideration of the calcium-phosphorus ratio in conjunction with the percentage amount of these elements in the pasture samples in the course of the year and in different regions of the Union. For this purpose the eighteen areas have been grouped as indicated in Table 16, those somewhat similar in regard to the calcium and phosphorus contents of their pastures falling within the same group. From the average figures for calcium and phosphorus in Tables 2 and 8 those given in Table 16 for sets of areas have been calculated.

As may be expected in view of the seasonal fluctuations of calcium and phosphorus previously discussed the proportion of calcium to phosphorus is greatest during the dry winter months in all grass pastures. In the first group (Areas 1 to 4, 7, and 8) the ratio increases from 2·19 in November to a maximum of 4·30 in July. Areas 5 and 6 with higher figures for both elements, show somewhat lower minimum and maximum calcium-phosphorus ratios than the first group of areas. The calcium figures for the two sections, Area 10 and Areas 9, 11 and 12, of the Parkland region are practically the same, but owing to better phosporus values in the pastures of Area 10 the proportion of calcium to phosphorus in this area varies from 2·48 to 5·38 as against a minimum of 2·84 and a maximum of as high as 8·72 in the pastures of Areas 9, 11 and 12.

In spite of calcium values about twice as high as those for the grass areas in the first group, the ratios of this element to phosphorus in Areas 13 and 14 are very similar to those in the said group of grass pastures, ranging from 2·25 to 4·77. Ratios in the pastures of Areas 15 and 16 remain high throughout the year, fluctuating from 5·25 to 6·29, while the highest proportions of calcium to phosphorus, viz., 7·48 to 11·52, occur in the Desert Succulent and Desert Grass pastures (Areas 17 and 18) of the North-Western Cape.

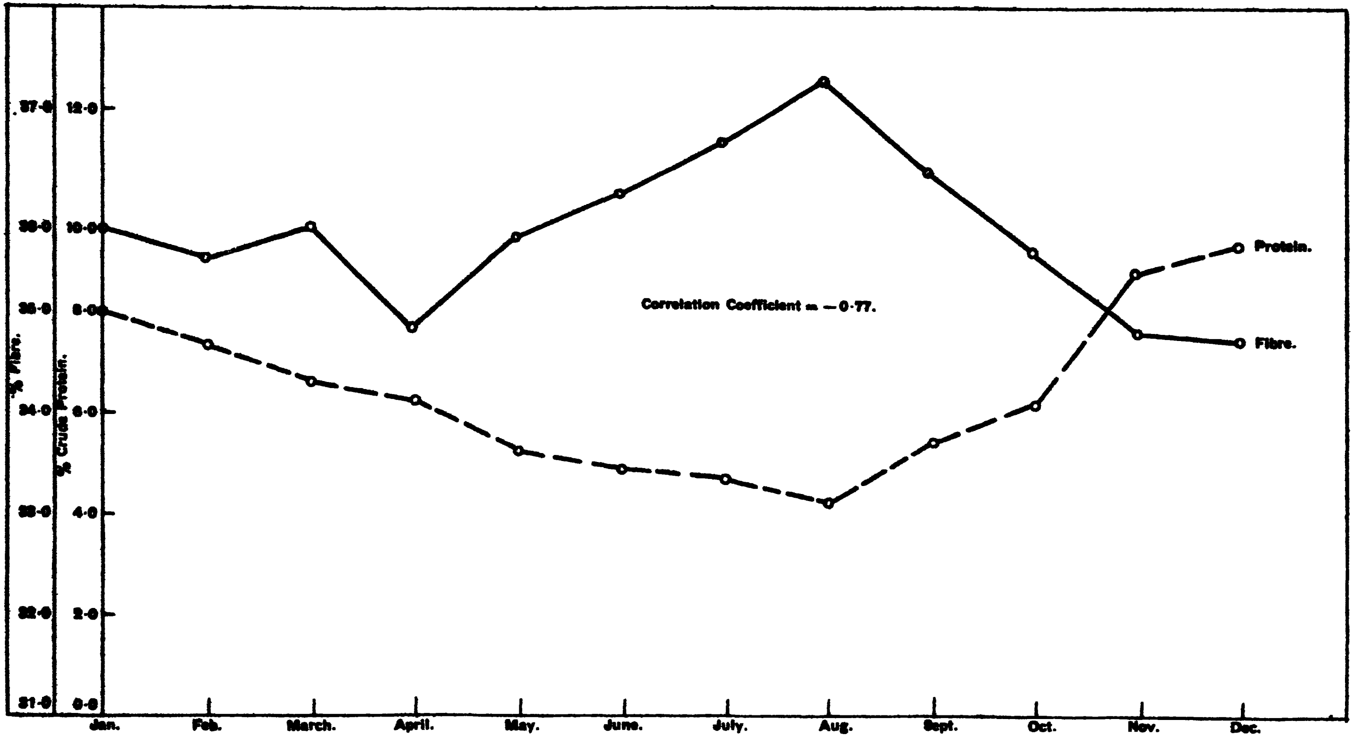


Fig. 6.—Showing the seasonal variations in the mean crude protein and crude fibre contents of the natural grass pastures of areas 1-12.

It is doubtful whether the ratios of calcium to phosphorus are sufficiently unfavourable to have any determinable effect on the growth of animals under conditions of practical farming except perhaps during periods of acute phosphorus deficiency. Under such conditions, rectifying the phosphorus deficiency would be the first concern, which then automatically improves the ratio problem. There can be no doubt that an unfavourable ratio of calcium to phosphorus, especially when the latter is present in insufficient amounts, as is almost invariably the case throughout winter in South African pastures, enhances the bad effects of the phosphorus deficiency considerably, but it has not been possible to show that ranching cattle receiving a phosphatic supplement in accordance with their needs were effected significantly by increasing the calcium-phosphorus ratio of their intake from 3·4:1 to 10:1. This is fortunate, as the use of most phosphatic supplements in practice, such as bone-meal, precipitated calcium phosphate, degelatinized bone-flour, etc., would increase the calcium intake of stock which is usually already considerably in excess of the phosphorus contained in the pasture eaten . Calcium-free supplements, such as sodium phosphate, would be preferable, but their use for feeding is almost prohibited by their cost. It is considered, however, that taking the pastures throughout the year and the variation of their calcium-phosphorus ratios from approximately normal values during the periods of active growth to unfavourable ratios during periods of food scarcity, such as drought and winter, in summer rainfall areas when phosphatic supplements are usually given and incidentally improvement of the ratio brought about, what appears to be a periodically unfavourable ratio, is without practical effect on animals entirely dependent on pasture for their food supply. At all events, it was not possible to demonstrate any effect on growth and blood phosphorus in the case of growing cattle that were running on pasture and receiving a calcium and phosphorus supplement daily to ensure a Ca:P ratio of 10:1 of their feed for a period of two years.

## IV. GENERAL SUMMARY AND CONCLUSIONS.

A final report is submitted on work started in 1930 on the mineral content and feeding value of South African natural pastures.

In the course of two successive years close on five thousand samples of natural pasturage were collected by following grazing animals on farms situated all over the Union of South Africa and forwarded to Onderstepoort, where they were chemically analysed. The object in following animals while the samples were being collected was to ensure that such samples were as closely as possible representative of what the animals actually consumed on the day of collection. All samples were analysed for crude protein, crude fibre, silica-free ash, phosphorus, calcium, magnesium, potassium, sodium, and chlorine.

For the purpose of discussing the results obtained the country as a whole has been divided into eighteen different areas and tables giving the average composition from month to month of the pastures in each area separately constructed.

The following is a brief summary of the results obtained.

(1) The chemical composition of grass pastures differs in many respects considerably from that of bush pastures. Especially is this the case in connection with the changes to which the composition of pastures are subject with changing meteorological conditions from January to December.

(2) Bush pastures are on the whole richer in all the constituents determined than are grass pastures. Another distinguishing feature in the two veld types is the difference in chemical composition between winter and summer pasturage: whereas the former type shows only minor fluctuations in the course of the year, the difference in the percentage contents of certain constituents during winter and summer are considerable in the case of grass pastures.

(3) Qualitative differences in the pastures of specific regions within any one of the two main veld types are also encountered.

(4) Expressed as percentages of the dry matter the phosphorus content of grass pastures is 0·12-0·17 during summer and 0·05-0·07 during winter. In the pastures composed mainly of bushes this constituent varies between 0·11 and 0·20 per cent. Crude protein values of the grass pastures fall from 7·0-9·0 per cent. in summer to 3·3-4·0 per cent. in winter, while the percentage of this constituent in those pastures composed mainly or wholly of bushes varies between 7·0 and 10·0 in the course of the year.

(5) Calcium and magnesium values show only minor seasonal variations. Differences in the percentage contents of these constituents are, however, appreciable in the pastures of one region as against those of another. Expressed as an annual mean the variation in the calcium and magnesium contents of grass pastures in different regions are 0·25-0·48 per cent. and 0·12-0·21 per cent., respectively. Similarly, the calcium and magnesium averages for bush pastures are 0·60-1·05 per cent. and 0·21-0·37 per cent., respectively, depending on the region.

(6) Maximum potassium and chlorine values occurring during summer in the grass pastures are 1·32-2·31 per cent. and 0·32-0·59 per cent., respectively. During winter the former constituent varies between 0·29 and 0·63 per cent. and the latter between 0·06 and 0·22 per cent. in the grass pastures of different regions. Sodium average figures fall from a maximum of 0·08 per cent. to a minimum of only 0·01 per cent. in some grass pastures while in others these values vary between 0·10 and 0·25 per cent. in the course of the year.

(7) The percentage potassium remains comparatively high throughout the year in most bush pastures. Values seldom are below 1·00 per cent., while most figures fluctuate between 1·40 and 2·00 per cent. Sodium and chlorine averages are exceptionally high in

some of the pastures composed mainly of bushes. Thus, for the greater part of the year figures for sodium are 1·00-1·86 per cent., and chlorine values exceed 0·70 per cent.

(8) Crude fibre averages are lowest in pasture at the younger stages of growth, the mean annual variation is 34·6-37·2 per cent. for grass pastures and 32·0-35·0 per cent. for bush pastures.

(9) Calcium-phosphorus ratios ranging from 2·00:1 to 11·60:1 occur in the dry matter of South African pastures.

(10) Judged by the estimated requirements of cattle and sheep for growth all South African natural pastures, composed mainly or wholly of grasses are deficient in phosphorus, crude protein and, in certain areas, sodium for a period ranging from five to nine months of the year, depending on the area. There are indications that in certain of these regions the pasture may be deficient in phosphorus throughout the year. Furthermore, on the basis of the average values for phosporus these grass pastures contain at no time of the year sufficient of this nutrient to provide in the requirement for an additional function (e.g., gestation or lactation) of the animal, superimposed on growth.

(11) Provided sufficient food is available an intake of phosphorus, crude protein or sodium below the optimum requirements for growth will seldom occur on pastures composed mainly of bushes.

(12) The requirements of calcium, magnesium and potassium for growth and moderate milk production will at all times be met by the amounts of these constituents present in South African pastures. Especially is the danger of a potassium and magnesium deficiency extremely remote.

(13) The pastures of the Union are at no time deficient in chlorine. A cow producing two gallons of milk may, however, not ingest sufficient of this constituent on the winter pastures of some of the grassland regions.

Since, unlike phosphorus or calcium, the reserves of which in the animal's body may tide it over a long period of inadequate intake without appreciably affecting its productive performance, protein undernourishment may immediately limit production or prevent it entirely, the low level of this constituent existing for several months in each year in most natural pasturages must be considered the limiting factor in the productivity of both cattle and sheep in this country. This and other deficiencies occurring simultaneously in the diet will result in a generally lowered metabolic rate and this condition again may be responsible for the circumstance that symptoms characteristic of an individual mineral deficiency such as phosphorus are not manifested under practical conditions of farming to the extent which a consideration of the average phosphorus content of our pastures, as reflected in this report, in relation to the estimated requirement of the animal for this constituent, would lead one to expect.

In conclusion it may be stated that from a study of the data presented in these pages it seems justified to infer that the practice of feeding phosphorus supplements in certain areas, advocated by this

Institute for almost twenty years may with great advantage to the cattle and sheep industries be adopted in the greater part of the country and for the greater part of the year. Also, it is clear that the extreme deficiency of protein in our grass pastures during winter is a problem of equal, if not greater, importance than that of phosphorus deficiency. If the advantages which have been proved to result from a phosphorus supplement such as bonemeal are an indication of what may be expected from rectifying other deficits in our natural pasture the improvement or supplementation of winter pasture with the object of increasing the protein intake of animals should greatly benefit the cattle and sheep industries of this country.

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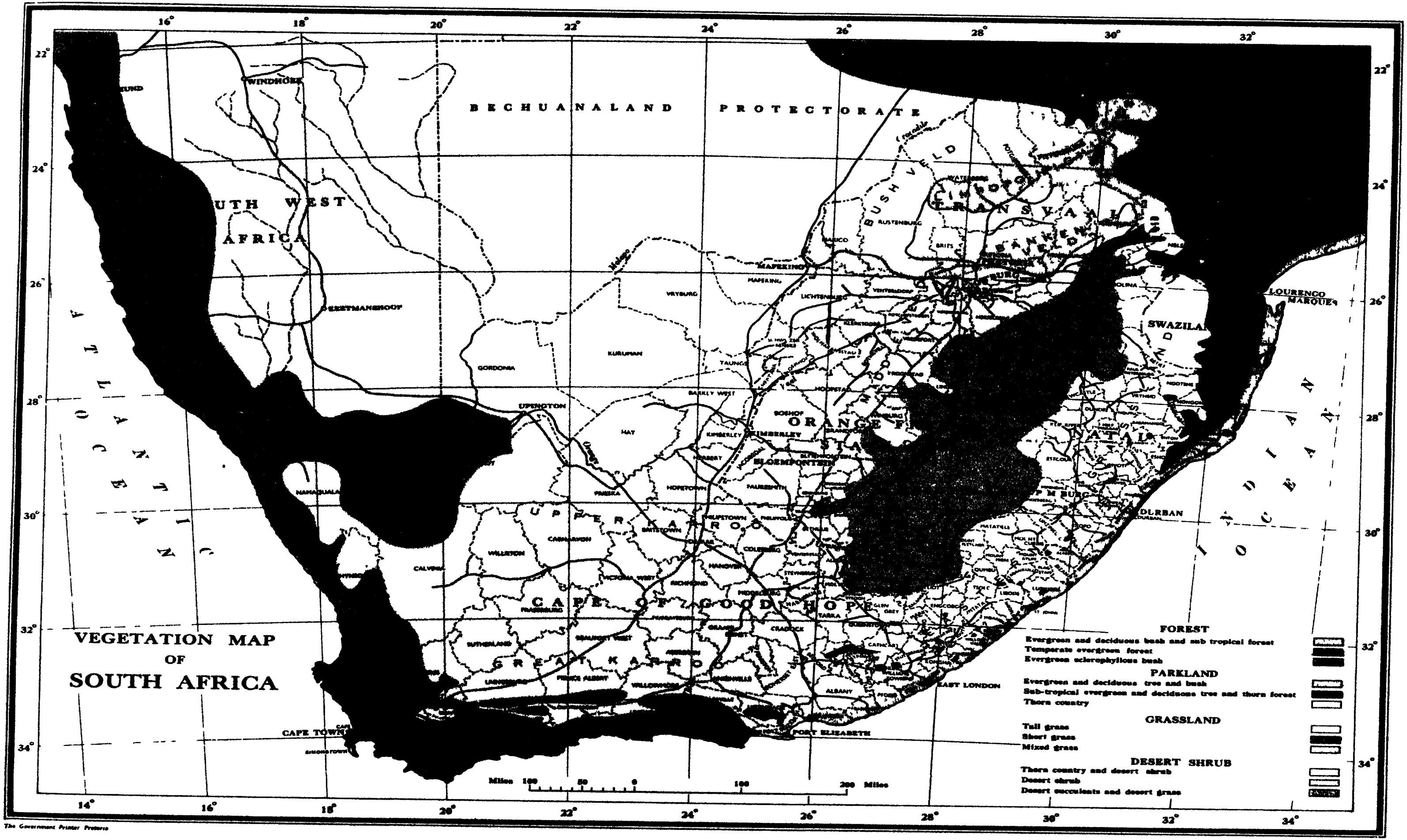

VEGETATION MAP
OF
SOUTH AFRICA

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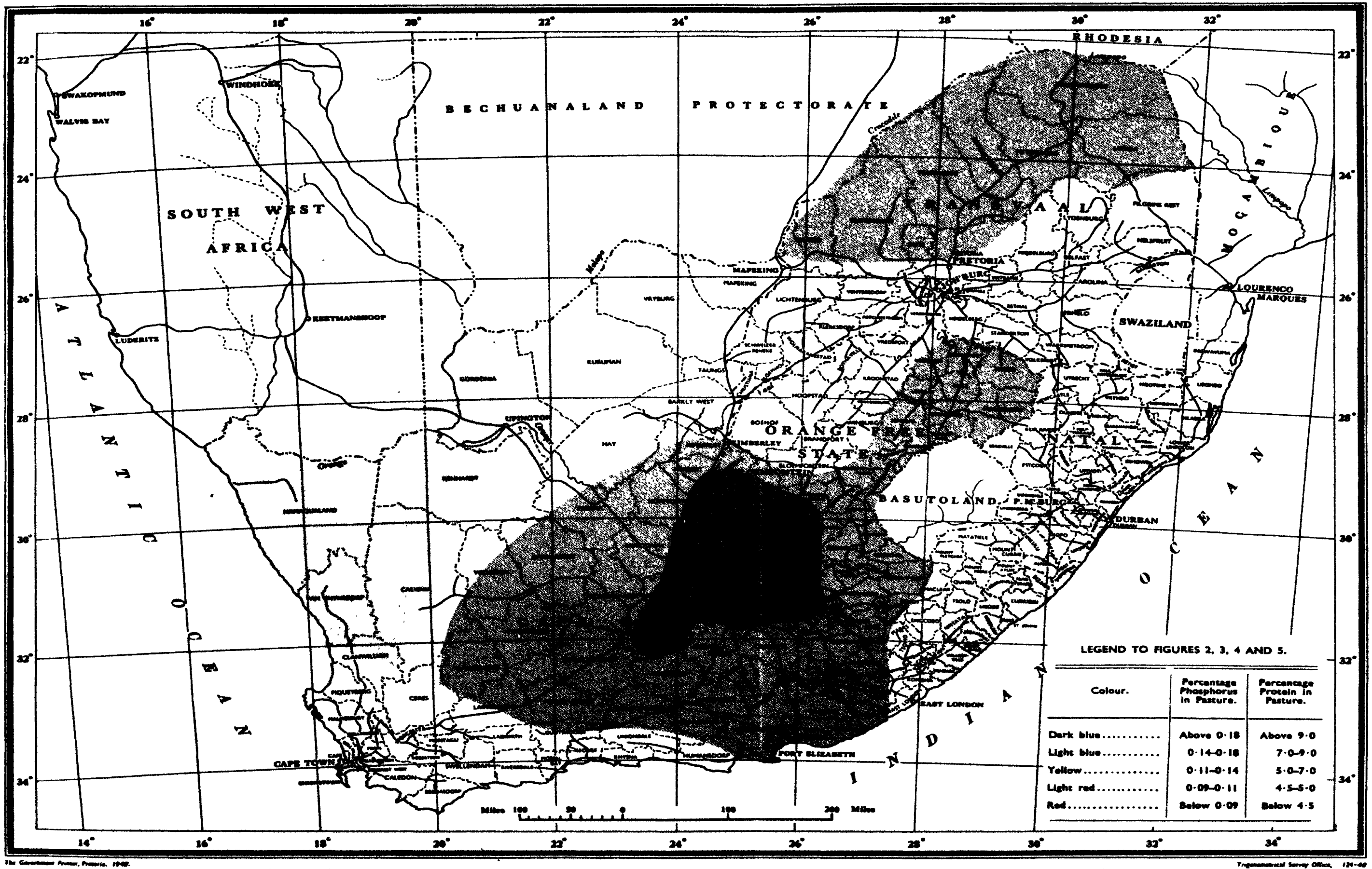
Trigonometrical Survey Office 36 38

## UNION OF SOUTH AFRICA



LEGEND TO FIGURES 2, 3, 4 AND 5.

| Colour. | Percentage Phosphorus in Pasture. | Percentage Protein in Pasture. |
|---|---|---|
| Dark blue.......... | Above 0·18 | Above 9·0 |
| Light blue.......... | 0·14–0·18 | 7·0–9·0 |
| Yellow.......... | 0·11–0·14 | 5·0–7·0 |
| Light red.......... | 0·09–0·11 | 4·5–5·0 |
| Red.......... | Below 0·09 | Below 4·5 |

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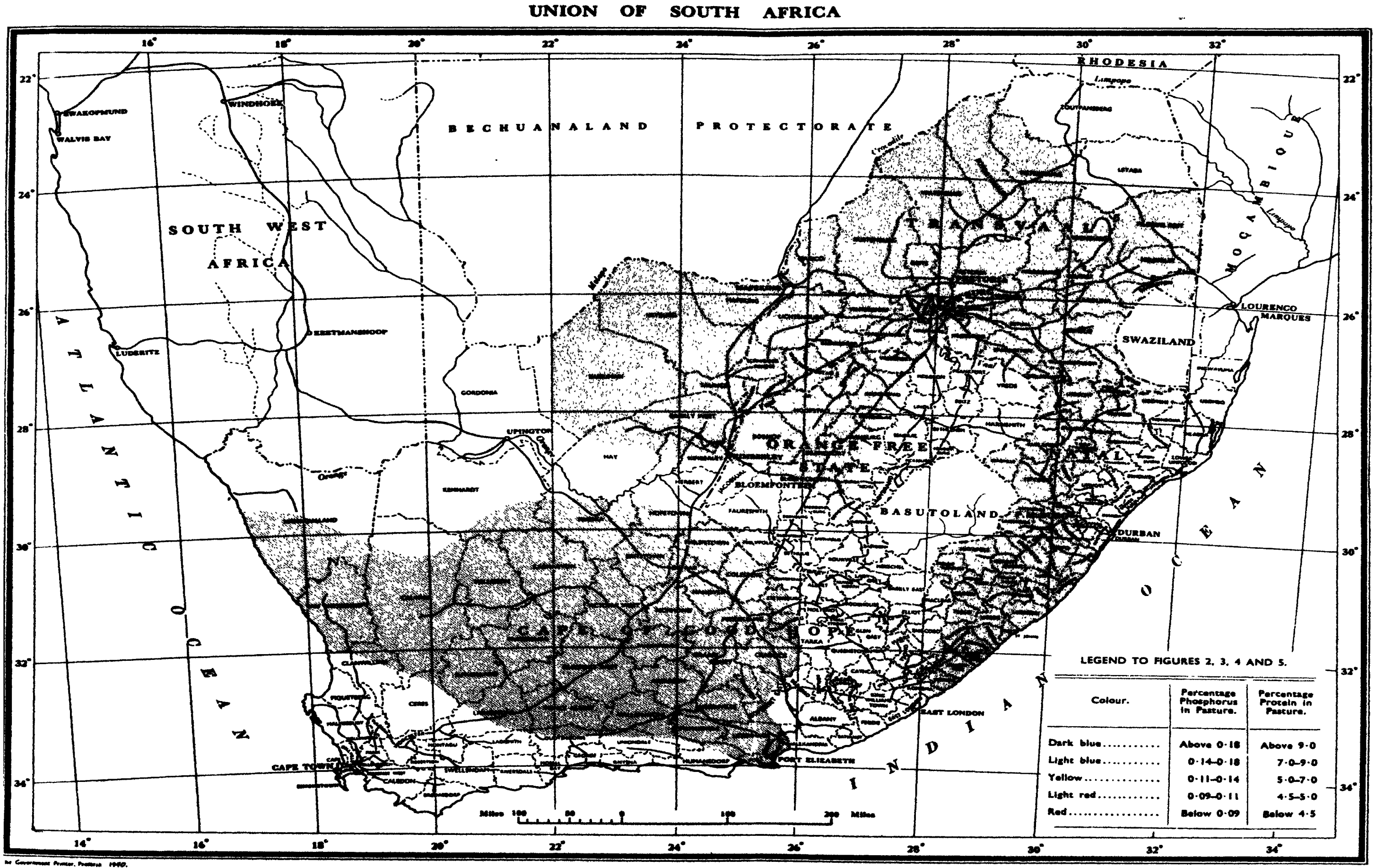
Trigonometrical Survey Office, 124-49

*FIGURE 2.*—SHOWING PHOSPHORUS CONTENT OF NATURAL PASTURES DURING SUMMER.



LEGEND TO FIGURES 2, 3, 4 AND 5.

| Colour. | Percentage Phosphorus in Pasture. | Percentage Protein in Pasture. |
|---|---|---|
| Dark blue.......... | Above 0·18 | Above 9·0 |
| Light blue.......... | 0·14–0·18 | 7·0–9·0 |
| Yellow.............. | 0·11–0·14 | 5·0–7·0 |
| Light red........... | 0·09–0·11 | 4·5–5·0 |
| Red................. | Below 0·09 | Below 4·5 |

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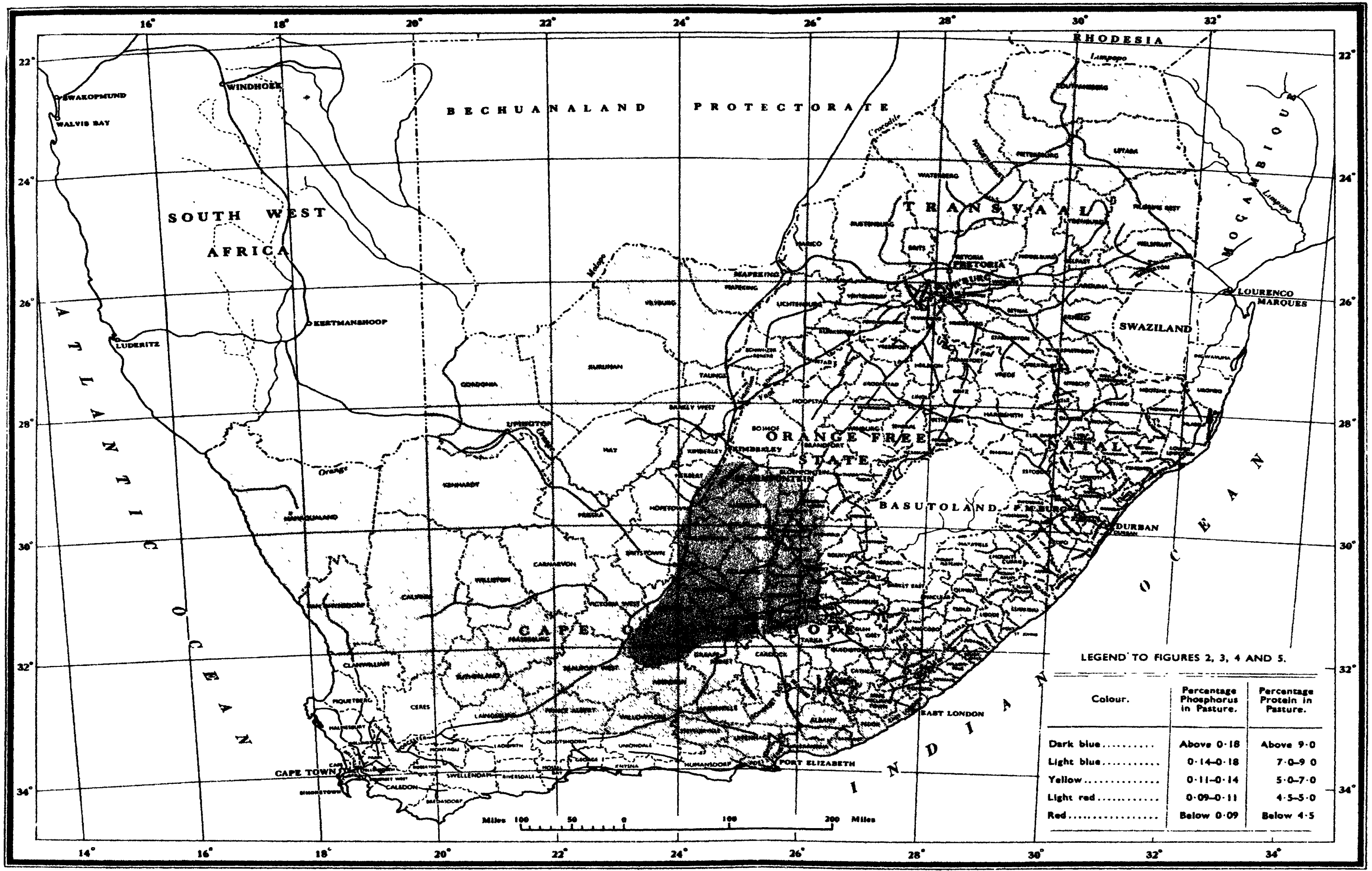
*FIGURE 3.*—SHOWING PHOSPHORUS CONTENT OF NATURAL PASTURES IN WINTER.

Trigonometrical Survey Office, 129-40

UNION OF SOUTH AFRICA



LEGEND TO FIGURES 2, 3, 4 AND 5.

| Colour. | Percentage Phosphorus in Pasture. | Percentage Protein in Pasture. |
|---|---|---|
| Dark blue.......... | Above 0·18 | Above 9·0 |
| Light blue.......... | 0·14–0·18 | 7·0–9·0 |
| Yellow.............. | 0·11–0·14 | 5·0–7·0 |
| Light red............ | 0·09–0·11 | 4·5–5·0 |
| Red.................. | Below 0·09 | Below 4·5 |

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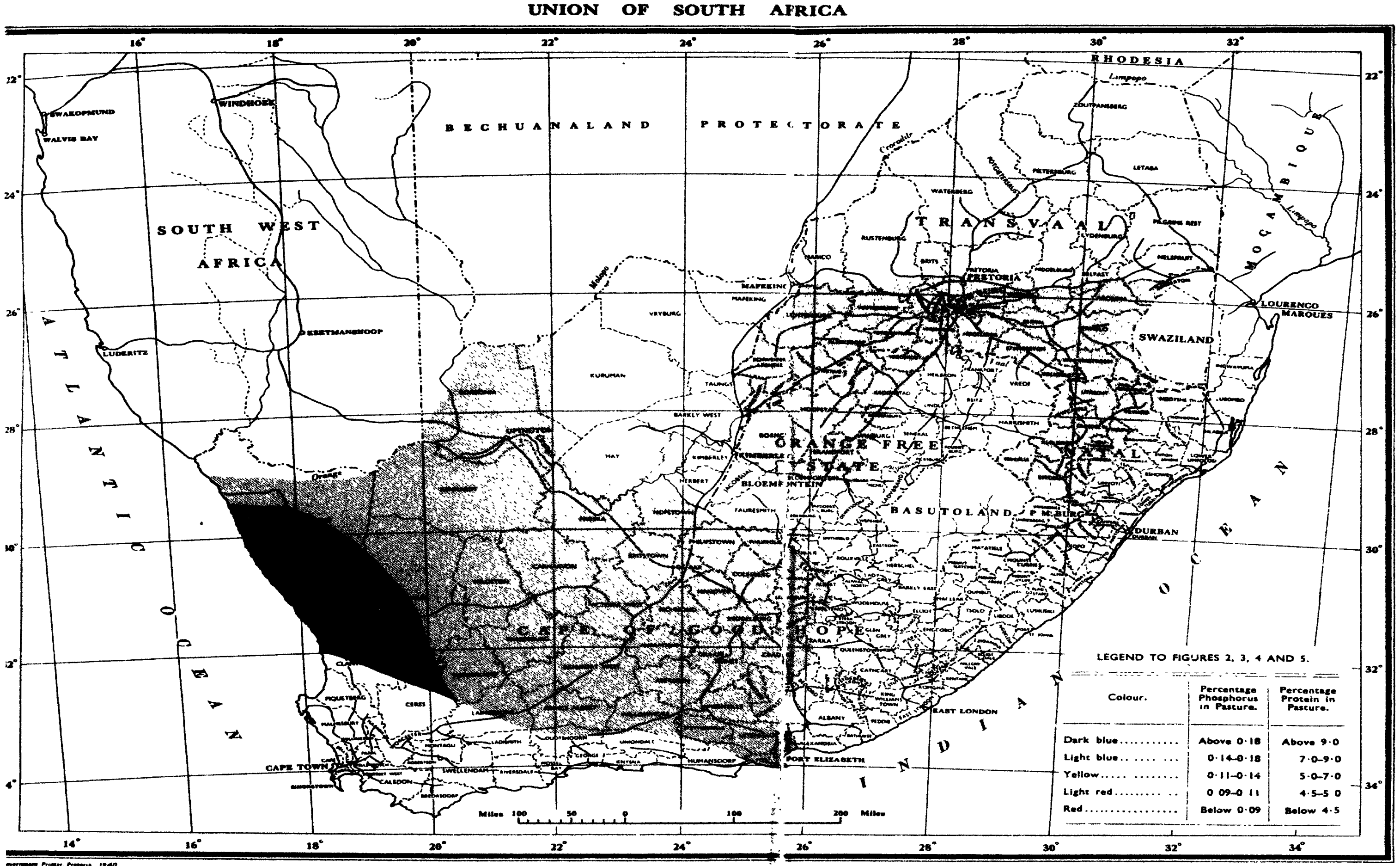
Trigonometrical Survey Office, 124-40

FIGURE 4.—SHOWING PROTEIN CONTENT OF NATURAL PASTURES IN SUMMER.



LEGEND TO FIGURES 2, 3, 4 AND 5.

| Colour. | Percentage Phosphorus in Pasture. | Percentage Protein in Pasture. |
|---|---|---|
| Dark blue.......... | Above 0·18 | Above 9·0 |
| Light blue.. .... ... | 0·14–0·18 | 7·0–9·0 |
| Yellow..... ........ | 0·11–0·14 | 5·0–7·0 |
| Light red......... .. | 0 09–0 11 | 4·5–5 0 |
| Red................ | Below 0·09 | Below 4·5 |

overnment Printer, Pretoria 1940

Trigonometrical Survey Office 124 40

*FIGURE 5.*—SHOWING PROTEIN CONTENT OF NATURAL PASTURES IN WINTER.

## VII. APPENDIX.

*Tables giving the origin, the date of collection, the chemical composition on a dry matter basis, and an approximate description of individual pasture samples from areas* 1 *to* 18 *representing the Union of South Africa.*

### AREA 1.

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Witrivier No. 14, P.O. Confidence | Piet Retief..... | Dec., 1933 | ·10 | ·33 | ·18 | 2·04 | ·05 | ·49 | 9·1 | 33·9 | 4·96 | Grass, mainly green. |
| | | Jul., 1934 | ·039 | ·23 | ·08 | ·20 | ·01 | ·03 | 2·9 | 35·9 | 1·27 | Grass, brown, leafy. |
| | | April, 1935 | ·12 | ·32 | ·13 | ·85 | ·02 | ·16 | 4·0 | 38·2 | 1·98 | Grass, long. |
| | | July, 1935 | ·073 | ·22 | ·10 | ·84 | ·03 | ·22 | 4·3 | 4·14 | 1·89 | Grass. |
| | | Oct., 1935 | ·070 | ·25 | ·06 | ·62 | ·04 | ·05 | 5·5 | 39·0 | 1·77 | Grass, mainly green, leafy. |
| Zendelingspost.... | Paulpietersburg | Feb., 1934 | ·18 | ·33 | ·14 | 1·62 | ·04 | ·24 | 6·0 | 37·7 | 3·53 | Grass, mainly green, short. |
| | | July, 1934 | ·042 | ·24 | ·08 | ·15 | trace | ·03 | 3·3 | 36·4 | 1·28 | Grass, brown, leafy. |
| | | Nov., 1934 | ·081 | ·23 | ·08 | ·68 | ·02 | ·15 | 5·6 | 34·7 | 1·77 | Grass, leafy. |
| | | June, 1935 | ·096 | ·34 | ·15 | 1·16 | trace | ·29 | 3·7 | 39·3 | 2·76 | Grass. |
| | | Sept. 1935 | ·054 | ·18 | ·15 | ·59 | ·02 | ·24 | 3·7 | 46·4 | 2·54 | Grass, brown, and bush; mostly grass. |
| Blesbokspruit No. 47 | Piet Retief..... | Nov., 1933 | ·23 | ·47 | ·31 | 2·47 | ·06 | ·64 | 12·5 | 32·8 | 5·82 | Grass and bush; mostly grass. |
| | | May, 1934 | ·095 | ·30 | ·16 | ·95 | ·01 | ·21 | 4·2 | 32·0 | 2·46 | Grass, mainly brown, leafy. |
| | | Jan., 1935 | ·13 | ·34 | ·13 | 1·51 | ·03 | ·34 | 10·1 | 32·8 | 3·08 | Grass, green, short. |
| Susanna No. 58, P.O. Bergen | Piet Retief..... | Feb., 1934 | ·08 | ·22 | ·29 | 1·17 | ·02 | ·24 | 6·2 | 39·0 | 3·30 | Grass. |
| | | June, 1934 | ·065 | ·42 | ·23 | ·63 | ·02 | ·20 | 5·0 | 35·2 | 3·45 | Grass, mainly brown, short. |
| | | Sept., 1934 | ·09 | ·29 | ·12 | 1·12 | ·12 | ·54 | 8·0 | 33·0 | 3·14 | Grass, mainly green, leafy. |
| | | Dec., 1934 | ·076 | ·34 | ·14 | 1·31 | ·28 | ·56 | 6·0 | 43·1 | 3·97 | Bush. |
| | | Mar., 1935 | ·092 | ·24 | ·15 | ·77 | ·04 | ·22 | 6·7 | 32·8 | 2·58 | Grass, mainly green, leafy. |
| Mooibank No. 12. | Piet Retief..... | Feb., 1934 | ·12 | ·20 | ·16 | 1·67 | ·03 | ·34 | 6·5 | 38·7 | 3·62 | Grass, mainly green, long and bush; mostly grass. |
| | | April, 1934 | ·12 | ·34 | ·18 | 1·01 | ·03 | ·24 | 6·3 | 34·7 | 3·22 | Grass, short. |
| | | July, 1934 | ·089 | ·51 | ·15 | ·62 | ·03 | ·08 | 4·4 | 35·8 | 2·88 | Grass, brown, leafy. |
| | | Oct., 1934 | ·087 | ·22 | ·14 | ·88 | ·11 | ·42 | 7·2 | 35·3 | 2·75 | Grass, leafy. |
| | | Feb., 1935 | ·096 | ·23 | ·11 | 1·24 | ·03 | ·25 | 6·1 | 36·2 | 2·48 | Grass, green, leafy. |
| Hartbeestfontein. | Ermelo........ | Dec., 1933 | ·079 | ·17 | ·11 | 1·26 | ·03 | ·19 | 7·1 | 37·8 | 2·55 | Grass. |
| | | Mar., 1934 | ·075 | ·31 | ·25 | ·71 | ·01 | ·18 | 5·5 | 34·6 | 2·09 | Grass, mainly green. |
| | | June, 1934 | ·03 | ·27 | ·13 | ·33 | ·02 | ·07 | 3·0 | 35·5 | 1·54 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·029 | ·39 | ·07 | ·13 | trace | ·04 | 3·7 | 36·7 | 1·12 | Grass, mainly brown, leafy. |
| | | Dec., 1934 | ·10 | ·18 | ·11 | 1·27 | trace | ·30 | 9·4 | 36·9 | 2·58 | Grass, mainly green, leafy. |
| | | Mar., 1935 | ·077 | ·32 | ·14 | ·65 | ·04 | ·13 | 5·7 | 35·0 | 2·13 | Grass, green. |
| | | June, 1935 | ·062 | ·22 | ·11 | ·35 | trace | ·07 | 3·0 | 38·7 | 1·32 | Grass, brown, leafy. |
| | | Sept., 1935 | ·075 | ·37 | ·16 | ·28 | ·15 | ·16 | 4·2 | 34·9 | 2·16 | Grass, brown, leafy. |

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inhwemfies, P.O. Panbult | Piet Retief..... | Jan., 1934 | ·079 | ·29 | ·21 | 1·25 | ·03 | ·29 | 6·3 | 38·7 | 3·09 | Grass, mainly green. |
| | | April, 1924 | ·10 | ·31 | ·15 | ·55 | ·02 | ·12 | 5·9 | 34·8 | 2·04 | Grass, mainly green, leafy. |
| | | July, 1934 | ·027 | ·19 | ·10 | ·13 | ·01 | ·03 | 3·9 | 33·3 | 1·19 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·048 | ·12 | ·06 | ·22 | ·02 | ·04 | 4·3 | 40·0 | 1·15 | Grass, mainly brown, leafy. |
| | | Jan., 1935 | ·11 | ·27 | ·18 | 1·36 | trace | ·13 | 8·6 | 36·2 | 2·56 | Grass, green, leafy. |
| | | April, 1935 | ·053 | ·26 | ·15 | ·51 | trace | ·09 | 5·6 | 35·6 | 1·62 | Grass, mainly green. |
| | | July, 1935 | ·053 | ·26 | ·12 | ·19 | ·03 | ·04 | 2·8 | 41·5 | 1·62 | Grass, brown, leafy. |
| Sluis No. 140.... | Piet Retief..... | Feb., 1934 | ·077 | ·20 | ·13 | 1·19 | ·04 | ·21 | 7·7 | 38·5 | 2·26 | Grass, mainly green. |
| | | May, 1934 | ·033 | ·22 | ·14 | ·55 | trace | ·15 | 4·8 | 36·7 | 1·57 | Grass, leafy. |
| | | Aug., 1934 | ·027 | ·22 | ·10 | ·09 | trace | ·02 | 2·6 | 36·8 | ·93 | Grass, mainly brown, leafy. |
| | | Nov., 1934 | ·082 | ·16 | ·09 | ·92 | ·03 | ·22 | 7·6 | 36·3 | 2·11 | Grass, mainly green, leafy. |
| | | Feb., 1935 | ·066 | ·35 | ·17 | ·86 | ·05 | ·19 | 5·6 | 35·6 | 2·21 | Grass, green, leafy. |
| | | May, 1935 | ·049 | ·27 | ·14 | ·29 | ·06 | ·08 | 3·0 | 32·6 | 1·42 | Grass, leafy. |
| | | Aug., 1935 | ·053 | ·30 | ·12 | ·28 | ·07 | ·07 | 3·3 | 37·7 | 1·66 | Grass, brown, leafy. |
| Vryegunst, P.O. Commondale | Piet Retief..... | Feb., 1934 | ·10 | ·26 | ·17 | 1·50 | ·03 | ·33 | 6·6 | 39·0 | 2·88 | Grass, mainly green, short. |
| | | July, 1934 | ·038 | ·24 | ·06 | ·15 | ·01 | ·03 | 2·8 | 35·4 | 1·23 | Grass, brown, leafy. |
| | | May, 1935 | ·085 | ·31 | ·12 | 1·35 | ·03 | ·33 | 5·8 | 36·9 | 2·37 | Grass, mainly green. |
| Bergplaats, P.O. Mahamba | Piet Retief..... | Dec., 1933 | ·12 | ·26 | ·19 | ·90 | ·03 | ·45 | 6·3 | 35·7 | 3·44 | Grass, mainly green. |
| | | June, 1934 | — | ·28 | ·12 | ·62 | ·02 | — | 3·5 | 33·7 | 1·79 | Grass, mainly brown. |
| | | Nov., 1934 | ·14 | ·74 | ·39 | 1·91 | ·25 | ·77 | 10·0 | 30·0 | 6·10 | Grass, green and bush. |
| | | Feb., 1935 | ·13 | ·44 | ·24 | 1·82 | ·27 | ·60 | 7·8 | 32·3 | 4·48 | Grass, green, leafy. |
| | | May, 1935 | ·15 | ·44 | ·28 | 1·36 | ·26 | ·65 | 7·9 | 29·7 | 4·08 | Grass, green, leafy. |
| | | Aug., 1935 | ·073 | ·26 | ·16 | ·61 | ·03 | ·17 | 3·6 | 41·2 | 1·95 | Grass. |
| Rosendal........ | Ermelo........ | Mar., 1934 | ·13 | ·19 | ·13 | 1·40 | ·02 | ·29 | 5·9 | 38·5 | 2·97 | Grass, mainly green. |
| | | June, 1934 | ·059 | ·33 | ·13 | ·39 | ·03 | ·10 | 3·1 | 39·8 | 1·75 | Grass, mainly brown, long. |
| | | Dec., 1934 | ·18 | ·60 | ·21 | 2·36 | ·11 | ·59 | 10·2 | 29·4 | 5·36 | Grass, green and bush; mostly grass. |
| | | Mar., 1935 | ·12 | ·33 | ·15 | 1·20 | ·28 | ·38 | 4·7 | 37·5 | 3·58 | Grass, mainly green. |
| | | June, 1935 | ·082 | ·27 | ·13 | ·75 | trace | ·22 | 4·5 | 38·5 | 1·95 | Grass, mainly green. |
| | | Sept., 1935 | ·092 | ·23 | ·10 | 1·26 | ·17 | ·58 | 6·0 | 39·4 | 3·25 | Grass, leafy. |
| Rebokfontein, P.O. Mhlotsheni | Zwasiland...... | April, 1934 | ·12 | ·21 | ·09 | 1·50 | ·05 | ·37 | 5·4 | 40·5 | 2·90 | Grass, mainly green. |
| | | July, 1934 | ·039 | ·26 | ·16 | ·36 | ·02 | ·18 | 3·7 | 36·0 | 1·36 | Grass, mainly brown, long. |
| | | April, 1935 | ·079 | ·23 | ·18 | 1·45 | ·19 | ·67 | 6·5 | 38·4 | 3·33 | Grass, mainly green. |
| | | July, 1935 | ·093 | ·24 | ·18 | ·83 | ·16 | ·44 | 5·8 | 38·0 | 2·56 | Grass, mainly green. |
| | | Oct., 1935 | ·13 | ·28 | ·12 | 2·05 | ·22 | ·90 | 8·4 | 35·8 | 4·78 | Grass, mainly green. |
| Excelsior P.O. Panbult | Piet Retief..... | Dec., 1933 | ·083 | ·29 | ·20 | 1·00 | ·03 | ·33 | 6·9 | 34·8 | 4·09 | Grass, mainly green, short. |
| | | Mar., 1934 | ·11 | ·35 | ·24 | 1·78 | ·17 | ·61 | 6·6 | 32·2 | 3·96 | Grass, short. |
| | | June, 1934 | ·050 | ·32 | ·18 | ·72 | ·06 | ·14 | 3·0 | 33·6 | 2·28 | Grass, mainly brown. |
| | | Nov., 1934 | ·084 | ·31 | ·14 | ·68 | ·12 | ·31 | 4·4 | 33·3 | 2·31 | Grass, mainly green. |
| | | May, 1935 | ·08 | ·16 | ·10 | ·84 | trace | ·10 | 3·9 | 40·2 | 1·72 | Grass, long. |
| | | Oct., 1935 | ·059 | ·18 | ·08 | ·42 | ·03 | ·06 | 5·4 | 39·8 | 1·45 | Grass, mainly brown, leafy. |

AREA 1 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Meyershoop, P.O. Wittenberg** | Piet Retief | Jan., 1934 | 15 | ·18 | 12 | 1 12 | ·06 | ·28 | 8·8 | 40·7 | 2·43 | Grass, mainly green. |
| | | April, 1934 | 12 | 42 | 21 | 1 82 | ·02 | 39 | 4·3 | 39 9 | 3·08 | Grass, short. |
| | | July, 1934 | ·04 | 37 | 19 | 65 | 01 | 40 | 3·2 | 34·4 | 2·37 | Grass, mainly brown, short. |
| | | Dec., 1934 | 077 | 33 | ·20 | 87 | 05 | 33 | 4·6 | 37·8 | 2 56 | Grass, leafy. |
| | | Mar., 1935 | ·068 | ·33 | 13 | ·76 | ·04 | ·19 | 4 3 | 39·0 | 2·26 | Grass. |
| **Umkonta** | Piet Retief | Feb., 1924 | ·090 | ·24 | ·16 | 1·36 | 04 | 39 | 6 3 | 37·3 | 3·14 | Grass, short. |
| | | May, 1934 | ·058 | 20 | 11 | 68 | trace | ·14 | 4 5 | 34 8 | 1 55 | Grass. |
| | | Jan., 1935 | ·082 | 36 | 16 | 1·32 | 03 | 31 | 5·7 | 36·8 | 2·74 | Grass, green, leafy. |
| | | April, 1935 | 068 | 32 | ·19 | ·84 | trace | 12 | 4·6 | 30·2 | 2·44 | Grass, mainly green. |
| | | Sept., 1935 | ·051 | ·21 | ·07 | 38 | trace | ·11 | 3 6 | 41·8 | 1·39 | Grass, mainly brown. |
| **Hebron No. 185.** | Piet Retief | Nov., 1933 | ·13 | 29 | 22 | 1·73 | ·03 | 41 | 10·5 | 33·8 | 3·77 | Grass, mainly green. |
| | | Feb., 1934 | 079 | 31 | 18 | 1·29 | 02 | 37 | 6 3 | 37·7 | 2·94 | Grass. |
| | | May, 1934 | ·078 | ·42 | ·24 | ·75 | ·02 | ·27 | 5 6 | 36·1 | 2·81 | Grass, leafy. |
| | | Aug., 1934 | ·054 | 28 | ·14 | ·38 | 01 | 08 | 5 6 | 35·9 | 2·15 | Grass, mainly brown, short. |
| | | Feb., 1935 | ·080 | 28 | 10 | 1·03 | ·04 | ·34 | 5 2 | 37·7 | 2·34 | Grass, green, leafy. |
| | | May, 1935 | 064 | 36 | ·15 | ·46 | ·02 | 11 | 4·0 | 33·4 | 2·08 | Grass, mainly brown, leafy. |
| | | Sept., 1935 | ·039 | ·22 | 11 | ·30 | ·05 | 15 | 2 3 | 46·5 | 1·43 | Grass, brown, long. |
| **Burntop** | Piet Retief | Dec., 1933 | 14 | ·18 | ·10 | 2·06 | ·06 | 44 | 10·0 | 37·1 | 4·03 | Grass, short. |
| | | Mar., 1934 | 10 | 19 | 16 | 1·86 | ·02 | 39 | 6 8 | 35 8 | 3·37 | Grass, mainly green, short. |
| | | June, 1934 | 086 | 25 | ·13 | 1·06 | ·01 | ·27 | 4 1 | 38 4 | 2 30 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·062 | 26 | ·12 | ·77 | trace | 18 | 5·2 | 35 5 | 2·00 | Grass, leafy. |
| | | Mar., 1935 | ·12 | 33 | ·37 | 4·34 | ·07 | ·46 | 9 0 | 32·9 | 8·83 | Grass, green. |
| | | April, 1935 | ·077 | ·34 | ·07 | ·71 | ·10 | 27 | 5·0 | 35·8 | 2 39 | Grass, mainly green. |
| | | July, 1935 | ·054 | 24 | ·12 | ·31 | ·02 | ·08 | 2·6 | 43·7 | 1·56 | Grass, brown, long. |
| **Belfast** | Piet Retief | Jan., 1934 | ·10 | ·19 | ·11 | 1·39 | ·03 | ·28 | 7·3 | 37·4 | 3·16 | Grass, short. |
| | | April, 1924 | ·094 | -- | ·13 | 1 14 | ·02 | 43 | 5·9 | 36·1 | 3·51 | Grass, short. |
| | | July, 1934 | 028 | 21 | ·09 | ·31 | trace | ·11 | 3 6 | 40 5 | 1·38 | Grass, brown, leafy. |
| | | Oct., 1934 | 073 | 21 | ·07 | ·67 | 02 | 16 | 6·6 | 35·5 | 1·89 | Grass, leafy. |
| | | July, 1935 | 059 | ·25 | ·09 | ·28 | ·02 | ·11 | 2·5 | 42·2 | 1·51 | Grass, brown. |
| **Eden, P.O. Anysspruit** | Piet Retief | Mar., 1934 | ·079 | 35 | ·15 | 1·04 | ·03 | ·20 | 5·4 | 40·2 | 2·45 | Grass, mainly green. |
| | | June, 1934 | ·027 | 30 | ·12 | ·38 | ·02 | ·09 | 3·5 | 34·3 | 1·56 | Grass, mainly brown, short. |
| | | Oct., 1934 | 043 | 22 | ·05 | ·32 | trace | ·09 | 3 9 | 44 0 | 1·14 | Grass, long. |
| | | Jan., 1935 | ·12 | ·24 | ·17 | 1·20 | ·04 | 39 | 6·8 | 36·8 | 2·62 | Grass, green, long. |
| | | April, 1935 | ·10 | ·36 | ·19 | 1·83 | trace | 36 | 6 3 | 36·9 | 3·95 | Grass, mainly green, long. |
| **Uitgevallen, P.O. Bergen** | Piet Retief | April, 1934 | 082 | ·33 | ·15 | 1·02 | ·02 | ·20 | 5·7 | 34·9 | 2·39 | Grass, mainly green. |
| | | Nov., 1934 | ·061 | ·18 | ·05 | ·64 | trace | ·10 | 4·6 | 40·3 | 1·69 | Grass, leafy. |
| | | Feb., 1935 | ·095 | ·26 | ·11 | 1·05 | ·03 | ·24 | 5·2 | 37 4 | 2·45 | Grass, mainly green, leafy. |
| | | April, 1935 | ·10 | ·30 | ·28 | 1·34 | ·04 | ·30 | 6·3 | 48·7 | 3·06 | Grass, long. |

## AREA 1 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Marinthal**........ | Piet Retief..... | May, 1934 | ·061 | ·26 | ·12 | ·69 | ·03 | ·16 | 4·8 | 35·7 | 1·87 | Grass. |
| | | Aug., 1934 | ·09 | ·41 | ·16 | 1·34 | ·05 | ·29 | 4·3 | 35·8 | 3·64 | Grass, mainly brown. |
| | | Nov., 1934 | ·069 | ·23 | ·10 | ·77 | ·07 | ·34 | 4·4 | 36·6 | 1·77 | Grass, mainly green. |
| | | Feb., 1935 | ·073 | ·22 | ·11 | ·92 | trace | ·84 | 4·4 | 35·5 | 2·14 | Grass, mainly green. |
| **Edinburgh, P.O. Idalia** | Piet Retief..... | April, 1934 | ·13 | ·18 | ·09 | 1·57 | ·60 | ·36 | 9·4 | 38·0 | 3·99 | Grass, mainly green. |
| | | June, 1934 | ·056 | ·13 | ·11 | ·27 | ·02 | ·02 | 2·5 | 42·6 | ·90 | Grass, mainly brown, long. |
| | | Nov., 1934 | ·077 | ·20 | ·07 | ·75 | ·02 | ·23 | 6·9 | 38·5 | 1·99 | Grass, green, long. |
| | | April, 1935 | ·082 | ·22 | ·10 | ·48 | ·04 | ·24 | 4·5 | 37·1 | 2·62 | Grass, mainly brown, leafy. |
| | | Aug., 1935 | ·041 | ·29 | ·13 | ·23 | trace | ·07 | 2·3 | 36·0 | 1·51 | Grass, brown, leafy. |
| **Idalia**........... | Piet Retief..... | Feb., 1935 | ·076 | ·26 | ·11 | ·79 | ·20 | ·26 | 5·0 | 35·2 | 2·30 | Grass, green, leafy. |
| | | May, 1935 | ·054 | ·25 | ·09 | ·28 | ·02 | ·07 | 3·1 | 34·9 | 1·36 | Grass, mainly brown, leafy. |
| | | July, 1935 | ·051 | ·23 | ·08 | ·15 | ·02 | ·05 | 2·7 | 36·3 | 1·14 | Grass, brown. |
| | | Oct., 1935 | ·035 | ·20 | ·06 | ·17 | ·02 | ·02 | 3·7 | 38·6 | 1·26 | Grass, brown, leafy. |
| **Tafelkoppies, No. 9A, P.O. Idalia** | Piet Retief..... | Sept., 1934 | ·077 | ·21 | ·10 | ·72 | ·03 | ·14 | 4·5 | 36·4 | 2·06 | Grass, mainly brown. |
| | | Mar., 1935 | ·079 | ·33 | ·18 | ·65 | ·04 | ·15 | 4·3 | 34·3 | 1·97 | Grass, mainly green. |
| | | June, 1935 | ·075 | ·27 | ·14 | ·31 | trace | ·07 | 3·3 | 35·6 | 1·57 | Grass, mainly brown, leafy. |
| | | Sept., 1935 | ·053 | ·40 | ·15 | ·19 | ·04 | ·07 | 3·6 | 36·8 | 2·01 | Grass, brown, leafy. |
| **Speenkoppies, P.O. Moolman Sdg.** | Piet Retief..... | May, 1934 | ·063 | ·26 | ·17 | 1·22 | ·02 | ·14 | 5·0 | 35·6 | 2·69 | Grass, leafy and bush; mostly grass. |
| | | Aug., 1934 | ·043 | ·26 | ·14 | ·17 | trace | 03 | 3·2 | 37·9 | 1·27 | Grass, mainly brown, leafy. |
| | | Nov., 1934 | ·10 | ·23 | ·11 | 1·19 | ·07 | ·27 | 11·3 | 40·8 | 2·72 | Grass, green, long. |
| | | Mar., 1935 | ·072 | 30 | ·13 | ·83 | ·04 | ·17 | 4·6 | 36·7 | 2·25 | Grass, mainly green, long. |
| **Potgietershoop**... | Piet Retief..... | June, 1934 | ·047 | ·24 | ·10 | ·63 | ·01 | ·19 | 3·7 | 36·6 | 1·75 | Grass, mainly green, long. |
| | | Dec., 1934 | ·10 | ·20 | ·11 | 1·39 | trace | ·25 | 7·9 | 34·7 | 2·61 | Grass, green, long. |
| | | April, 1935 | ·071 | ·29 | ·07 | ·85 | ·03 | 22 | 5·2 | 39·7 | 1·94 | Grass, mainly brown. |
| | | June, 1935 | ·058 | ·39 | ·17 | ·40 | ·02 | ·20 | 3·4 | 35·7 | 2·12 | Grass, mainly brown, short. |
| | | Aug., 1935 | ·058 | ·22 | ·06 | ·54 | ·03 | ·17 | 3·5 | 41·0 | 1·75 | Grass, mainly brown. |
| **Witkloof**......... | Piet Retief..... | July, 1934 | ·029 | 38 | ·14 | ·10 | trace | ·03 | 2 5 | 36·3 | 1·43 | Grass, brown, leafy. |
| | | Jan., 1935 | ·098 | ·28 | ·14 | 1·47 | 04 | ·73 | 6·6 | 38·9 | 2·81 | Grass, mainly green. |
| | | May, 1935 | ·065 | ·23 | ·12 | ·47 | ·02 | ·11 | 3·1 | 34·8 | 1·63 | Grass, mainly brown, leafy. |
| **Vergelegen No. 68 P.O.Dirkiesdorp** | Wakkerstroom. | April, 1934 | ·083 | ·37 | ·17 | ·76 | ·02 | ·18 | 4·6 | 33·7 | 2·23 | Grass, short. |
| | | June, 1935 | ·064 | ·38 | ·14 | 25 | trace | 07 | 2·6 | 38·7 | 1·67 | Grass, mainly brown. |
| | | Sept., 1935 | ·11 | ·31 | ·12 | 1·56 | 04 | ·43 | 15·4 | 30·4 | 3 46 | Grass, green, short. |

AREA 1 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wonderfontein... | Vryheid....... | Nov., 1933 | ·079 | ·18 | ·08 | ·98 | ·09 | ·25 | 8·4 | 38·1 | 2·63 | Grass, mainly green. |
| | | Feb., 1934 | ·14 | ·19 | ·10 | 1·35 | ·04 | ·24 | 7·6 | 39·6 | 2·94 | Grass, mainly green. |
| | | April, 1934 | ·11 | ·25 | ·15 | 2·07 | ·08 | ·39 | 10·1 | 35·4 | 3·68 | Grass, mainly green, leafy. |
| | | July, 1934 | ·059 | ·34 | ·25 | ·23 | ·35 | ·48 | 4·0 | 32·1 | 2·27 | Grass, mainly brown. |
| | | Sept., 1934 | ·054 | ·19 | ·04 | ·28 | ·02 | ·06 | 6·3 | 37·7 | 1·43 | Grass, leafy. |
| | | Jan., 1935 | ·097 | ·22 | ·11 | 1·56 | ·03 | ·26 | 8·5 | 34·5 | 2·98 | Grass, mainly green, leafy. |
| | | April, 1935 | ·083 | ·30 | ·12 | ·75 | ·11 | ·16 | 4·4 | 32·9 | 2·58 | Grass, mainly green, leafy. |
| | | July, 1935 | ·072 | ·36 | ·12 | ·38 | ·08 | ·15 | 3·9 | 36·3 | 2·33 | Grass, mainly brown, leafy. |
| | | Oct., 1935 | ·08 | ·24 | ·17 | ·64 | ·28 | ·56 | 7·0 | 34·0 | 2·87 | Grass, green, leafy. |
| Weltevrede No. 541 | Vryheid....... | Dec., 1933 | ·13 | ·26 | ·08 | 1·28 | ·06 | ·26 | 8·3 | 39·5 | 3·05 | Grass, green. |
| | | Mar., 1934 | ·083 | ·30 | ·21 | 1·01 | ·03 | ·29 | 4·8 | 38·1 | 2·61 | Grass, mainly green. |
| | | May, 1934 | ·046 | ·21 | ·08 | ·71 | ·02 | ·20 | 4·0 | 37·1 | 2·11 | Grass, mainly brown. |
| | | Aug., 1934 | ·063 | ·34 | ·20 | ·35 | ·01 | ·05 | 3·9 | 38·4 | 2·09 | Grass, mainly brown. |
| | | Nov., 1934 | ·075 | ·19 | ·06 | ·81 | ·04 | ·17 | 7·2 | 37·9 | 1·67 | Grass, mainly green, leafy. |
| | | Feb., 1935 | ·078 | ·26 | ·10 | ·84 | ·04 | ·73 | 5·8 | 32·8 | 2·57 | Grass, mainly green, short. |
| | | May, 1935 | ·072 | ·25 | ·14 | ·48 | ·03 | ·10 | 5·2 | 30·8 | 2·00 | Grass, leafy. |
| | | Aug., 1935 | ·093 | ·27 | ·13 | ·38 | ·03 | ·15 | 2·3 | 40·4 | 1·63 | Grass, mainly brown, leafy. |
| Wagendrift....... | Vryheid....... | Jan., 1934 | ·064 | ·16 | ·14 | ·79 | ·02 | ·22 | 3·3 | 42·8 | 1·94 | Grass, long. |
| | | June, 1934 | ·042 | ·27 | ·12 | ·24 | ·02 | ·02 | 5·8 | 40·2 | 1·60 | Grass, mainly brown. |
| | | Oct., 1934 | ·071 | ·22 | ·14 | ·84 | ·02 | ·09 | 4·4 | 33·8 | 2·06 | Grass, mainly green, leafy. |
| | | Dec., 1934 | ·13 | ·32 | ·13 | 1·49 | ·18 | ·48 | 10·6 | 34·3 | 3·32 | Grass, mainly green, leafy. |
| | | Mar., 1935 | ·088 | ·25 | ·07 | ·47 | ·04 | ·21 | 5·7 | 35·0 | 2·64 | Grass, mainly green, leafy. |
| | | June, 1935 | ·05 | ·31 | ·12 | ·48 | trace | ·20 | 3·6 | 37·3 | 1·98 | Grass, mainly brown, leafy. |
| | | Sept., 1935 | ·083 | ·29 | ·15 | ·36 | ·03 | ·13 | 3·4 | 39·7 | 2·08 | Grass, mainly brown, leafy. |
| Beaufort......... | Vryheid....... | Nov., 1933 | ·20 | ·25 | ·16 | 1·76 | ·06 | ·44 | 9·6 | 34·7 | 4·05 | Grass, green. |
| | | Feb., 1934 | ·092 | ·22 | ·12 | 1·10 | ·01 | ·21 | 4·9 | 40·8 | 2·42 | Grass, mainly green. |
| | | May, 1934 | ·093 | ·29 | ·16 | ·92 | ·06 | ·33 | 4·1 | 38·3 | 2·40 | Grass. |
| | | Aug., 1934 | ·05 | ·18 | ·10 | ·40 | trace | ·08 | 2·6 | 44·5 | 1·50 | Grass, mainly brown. |
| | | April, 1935 | ·18 | ·25 | ·11 | 1·33 | trace | ·60 | 8·0 | 34·8 | 3·22 | Grass, green. |
| | | June, 1935 | ·12 | ·20 | ·07 | ·75 | trace | ·13 | 5·5 | 37·3 | 1·91 | Grass, brown. |
| | | Sept., 1935 | ·035 | ·30 | ·11 | ·27 | ·02 | ·06 | 2·5 | 39·4 | 1·37 | Grass, brown, long. |
| Sandhurst........ | Vryheid....... | Dec., 1933 | ·19 | ·31 | ·17 | 2·03 | ·06 | ·44 | 9·4 | 35·1 | 4·60 | Grass, green. |
| | | Mar., 1934 | ·11 | ·30 | ·20 | 1·29 | ·03 | ·37 | 5·2 | 40·3 | 3·00 | Grass, long. |
| | | June, 1934 | ·093 | ·37 | ·16 | ·55 | ·01 | ·15 | 8·9 | 36·4 | 2·29 | Grass, mainly brown, leafy |
| | | Sept., 1934 | ·059 | ·29 | ·09 | ·26 | trace | ·13 | 4·2 | 39·2 | 1·47 | Grass, mainly brown. |
| | | Feb., 1935 | ·09 | ·22 | ·10 | ·79 | ·03 | ·36 | 4·7 | 39·4 | 1·82 | Grass, mainly green. |
| | | May, 1935 | ·093 | ·31 | ·09 | ·65 | trace | ·09 | 4·4 | 35·5 | 1·85 | Grass, mainly brown, long. |
| | | Aug., 1935 | ·059 | ·31 | ·11 | ·75 | ·01 | ·19 | 3·5 | 42·0 | 1·96 | Grass, brown, long. |

## AREA 1 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dorie | Helpmekaar | May, 1934 | ·032 | ·63 | ·27 | ·36 | ·01 | ·15 | 2·7 | 37·4 | 2·70 | Grass, mainly brown, long. |
|  |  | Aug., 1934 | ·06 | ·30 | ·37 | ·40 | trace | ·13 | 2·3 | 40·9 | 1·87 | Grass, mainly brown, long. |
|  |  | Nov., 1934 | ·11 | ·37 | ·16 | 1·40 | trace | ·34 | 7·1 | 34·0 | 2·96 | Grass, mainly green, short. |
|  |  | Feb., 1935 | ·06 | ·25 | ·13 | ·40 | ·02 | ·16 | 3·1 | 43·5 | 1·92 | Grass, mainly brown, long. |
|  |  | May, 1935 | ·074 | ·28 | ·16 | ·50 | ·02 | ·12 | 3·3 | 37·4 | 1·90 | Grass, mainly brown. |
|  |  | Aug., 1935 | ·07 | ·32 | ·15 | ·28 | ·02 | ·19 | 2·6 | 41·9 | 1·68 | Grass, brown. |
| Cairnmore | Ngutu | Mar., 1934 | ·078 | ·47 | ·24 | ·75 | ·02 | ·22 | 5·6 | 36·1 | 2·65 | Grass, mainly green. |
|  |  | July, 1935 | ·074 | ·28 | ·12 | ·51 | ·03 | ·18 | 3·0 | 43·2 | 1·75 | Grass, mainly brown, long. |
|  |  | Oct., 1935 | ·064 | ·22 | ·15 | ·41 | ·02 | ·11 | 3·9 | 40·6 | 1·37 | Grass, mainly brown. |
| Sunrise | Ngutu | July, 1934 | ·087 | ·30 | ·14 | ·82 | ·01 | ·21 | 4·4 | 37·7 | 2·10 | Grass, mainly green. |
|  |  | April, 1935 | ·095 | ·31 | ·13 | ·76 | ·11 | ·22 | 5·0 | 36·1 | 2·15 | Grass, mainly green, long. |
|  |  | May, 1935 | ·074 | ·45 | ·16 | ·37 | ·03 | ·07 | 4·1 | 33·2 | 1·99 | Grass, leafy. |
|  |  | Sept., 1935 | ·042 | ·19 | ·08 | ·22 | trace | ·12 | 3·0 | 38·8 | 1·14 | Grass, mainly brown, leafy. |
| Dawn | Ngutu | Aug., 1934 | ·072 | ·20 | ·09 | ·54 | ·01 | ·12 | 4·0 | 41·4 | 1·60 | Grass, mainly brown. |
|  |  | Mar., 1935 | ·086 | ·21 | ·09 | 1·30 | trace | ·34 | 5·7 | 40·5 | 2·58 | Grass, green, long. |
|  |  | June, 1935 | ·072 | ·22 | ·08 | ·91 | trace | ·27 | 4·6 | 41·2 | 2·35 | Grass, mainly brown, long. |
|  |  | Aug., 1935 | ·053 | ·28 | ·07 | ·35 | ·02 | ·13 | 3·5 | 40·7 | 1·28 | Grass, mainly brown, long. |
| Balgray | Dundee | Mar., 1934 | ·14 | ·21 | ·10 | 1·23 | ·03 | ·24 | 6·3 | 37·4 | 2·65 | Grass, mainly green. |
|  |  | July, 1934 | ·016 | ·29 | ·09 | ·11 | trace | ·10 | 2·2 | 37·0 | 1·22 | Grass, mainly brown, leafy |
|  |  | Oct., 1934 | ·13 | ·29 | ·17 | 1·65 | ·15 | ·49 | 10·2 | 32·1 | 3·90 | Grass, green, short. |
|  |  | Jan., 1935 | ·17 | ·28 | ·14 | 1·54 | ·03 | ·30 | 8·9 | 33·6 | 3·19 | Grass, green, leafy. |
|  |  | Mar., 1935 | ·19 | ·31 | ·15 | 1·39 | trace | ·26 | 8·1 | 32·0 | 3·20 | Grass, green, short. |
|  |  | June, 1935 | ·053 | ·32 | ·09 | ·22 | trace | ·04 | 2·2 | 35·7 | 1·49 | Grass, brown, short. |
|  |  | July, 1935 | ·11 | ·27 | ·13 | ·47 | ·02 | ·07 | 5·7 | 31·3 | 2·36 | Grass, brown, leafy; and mealie leaves. |
|  |  | Sept., 1935 | ·04 | ·23 | ·05 | ·27 | ·03 | ·10 | 3·8 | 37·1 | 1·00 | Grass, brown. |
| Avoca | Dundee | May, 1934 | ·10 | ·28 | ·12 | ·90 | ·03 | ·16 | 4·7 | 34·1 | 2·18 | Grass, mainly green, leafy. |
|  |  | July, 1934 | ·03 | ·26 | ·07 | ·15 | trace | ·02 | 2·8 | 37·8 | 1·17 | Grass, brown, leafy. |
|  |  | Oct., 1934 | ·21 | ·32 | ·23 | 1·78 | ·06 | ·45 | 12·4 | 29·0 | 4·74 | Grass, green, leafy. |
|  |  | Jan., 1935 | ·094 | ·25 | ·14 | 1·26 | ·03 | ·22 | 5·9 | 35·1 | 2·45 | Grass, green, leafy. |
|  |  | April, 1935 | ·16 | ·33 | ·15 | ·96 | ·04 | ·18 | 5·9 | 33·7 | 2·95 | Grass, green, short. |
|  |  | Oct., 1935 | ·06 | ·25 | ·06 | ·29 | ·03 | ·05 | 4·3 | 36·9 | 1·44 | Grass, mainly brown, leafy. |
| Glenluce | Dundee | June, 1934 | ·098 | ·32 | ·18 | ·93 | ·02 | ·30 | 5·5 | 34·8 | 2·70 | Grass, leafy. |
|  |  | Sept., 1934 | ·15 | ·44 | ·15 | ·80 | ·03 | ·23 | 7·8 | 32·7 | 2·44 | Grass, mainly green, leafy. |
|  |  | Nov., 1934 | ·14 | ·33 | ·18 | 1·56 | trace | ·30 | 9·2 | 33·2 | 3·23 | Grass, green, short. |
|  |  | Feb., 1935 | ·11 | ·36 | ·21 | 1·20 | ·03 | ·35 | 6·9 | 35·5 | 3·02 | Grass, green, leafy. |
|  |  | May, 1935 | ·12 | ·37 | ·25 | ·86 | ·03 | ·18 | 5·2 | 33·3 | 2·75 | Grass, mainly green, short. |
|  |  | Aug., 1935 | ·063 | ·24 | ·10 | ·37 | trace | ·05 | 5·7 | 33·7 | 1·37 | Grass, brown, leafy. |

AREA 1 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Van Tondersrus.. | Dundee........ | Feb., 1934 | ·12 | ·29 | ·16 | 1·79 | ·06 | ·40 | 4·8 | 41·7 | 3·93 | Grass, mainly green, long. |
| | | Aug., 1934 | ·048 | ·30 | ·09 | ·20 | trace | ·03 | 3·4 | 38·9 | 1·36 | Grass, mainly brown. |
| | | Nov., 1934 | ·19 | ·41 | ·21 | 2 23 | ·09 | ·46 | 13·3 | 31·3 | 4·64 | Grass, green, leafy. |
| | | Mar., 1935 | ·16 | ·34 | ·16 | 1·54 | trace | ·38 | 5·2 | 36 7 | 3·39 | Grass, mainly green. leafy. |
| Rosewarne....... | Dundee........ | June, 1934 | ·091 | ·49 | ·23 | 1·73 | ·02 | ·22 | 3·9 | 41·5 | 4·10 | Grass, long. |
| | | Jan., 1935 | ·075 | ·27 | ·13 | 1·67 | ·04 | 21 | 5·8 | 40 6 | 3·13 | Grass, green, long. |
| Welgedaan....... | Dundee........ | July, 1934 | ·035 | 22 | ·06 | ·23 | trace | ·02 | 2·2 | 41·9 | 1·10 | Grass, mainly brown. |
| | | Oct., 1934 | ·052 | ·25 | ·07 | ·26 | ·01 | ·03 | 3·3 | 39·1 | 1·26 | Grass, mainly green, long. |
| | | May, 1935 | ·14 | ·29 | ·12 | ·90 | ·03 | ·12 | 5·3 | 37·4 | 2·26 | Grass, long. |
| Exchange........ | Newcastle...... | Feb., 1934 | ·095 | ·41 | ·18 | 1·34 | ·02 | ·38 | 6·6 | 33·8 | 3·27 | Grass, mainly green, leafy. |
| | | May, 1934 | ·11 | ·42 | ·29 | 1·41 | ·06 | ·52 | 8·1 | 35·5 | 3·72 | Grass, leafy. |
| | | Aug., 1934 | ·15 | ·31 | ·14 | ·84 | ·01 | ·24 | 8·1 | 35·1 | 2·46 | Grass, mainly green, leafy. |
| | | Feb., 1935 | ·12 | ·29 | ·15 | 1·34 | ·08 | ·43 | 7·1 | 36·3 | 3·11 | Grass, green, leafy. |
| | | May, 1935 | ·074 | ·34 | ·15 | ·66 | ·01 | ·08 | 4·1 | 34·1 | 2·10 | Grass. |
| | | Aug., 1935 | ·079 | ·26 | ·11 | ·65 | ·03 | ·21 | 2·9 | 36·7 | 1·75 | Grass, brown, leafy. |
| Drycut.......... | Newcastle...... | Mar., 1934 | ·17 | ·29 | ·14 | 1·00 | ·06 | ·39 | 9·7 | 33·2 | 3·74 | Grass, mainly green, leafy. |
| | | June, 1934 | ·12 | 54 | ·27 | 1·22 | ·06 | ·35 | 5·5 | 34·9 | — | Grass, leafy. |
| | | Sept., 1934 | ·14 | ·26 | ·13 | 1·19 | ·03 | ·37 | 10·1 | 34·1 | 2·66 | Grass, green, leafy. |
| | | Dec., 1934 | ·32 | ·34 | ·20 | 2·42 | trace | ·50 | 14·4 | 31·6 | 5·21 | Grass, green, leafy. |
| | | Mar., 1935 | ·21 | ·57 | ·15 | 1·64 | trace | ·31 | 10·5 | 32·3 | 3·50 | Grass, green, leafy. |
| | | June, 1935 | ·07 | ·27 | ·08 | ·55 | trace | ·10 | 3·3 | 38·1 | 1·91 | Grass, mainly brown, leafy. |
| | | Sept., 1935 | ·088 | ·25 | ·10 | ·53 | ·02 | ·10 | 4·3 | 36·2 | 1·76 | Grass, brown, short. |
| Highton......... | Newcastle...... | April, 1934 | ·12 | ·31 | ·22 | 1·04 | ·01 | ·26 | 6·1 | 34·4 | 2·70 | Grass, mainly green, leafy. |
| | | July, 1934 | ·063 | ·26 | ·11 | ·81 | ·01 | ·13 | 4·3 | 36·4 | 1·93 | Grass. |
| | | Oct., 1934 | ·11 | ·31 | ·18 | 1·04 | 06 | ·19 | 8·4 | 32·0 | 2·71 | Grass, green, leafy. |
| | | Jan., 1935 | ·13 | ·26 | ·15 | 1·52 | trace | ·39 | 9·0 | 33·8 | 3·19 | Grass, green, leafy. |
| | | April, 1935 | ·094 | ·29 | ·12 | ·89 | ·02 | ·22 | 5·7 | 35·9 | 2·56 | Grass, mainly green, leafy. |
| | | July, 1935 | ·068 | ·22 | ·13 | ·65 | ·01 | ·25 | 3·1 | 40·5 | 2·51 | Grass, mainly brown. |
| | | Oct., 1935 | ·048 | ·37 | ·09 | ·87 | ·02 | ·15 | 5·2 | 39·6 | 2·01 | Grass, mainly brown, leafy. |
| Eldorado........ | Utrecht........ | April, 1934 | ·18 | ·32 | ·12 | 1·06 | ·04 | ·16 | 5·6 | 34·4 | 2·68 | Grass, mainly green, leafy. |
| | | July, 1934 | ·081 | ·44 | ·25 | 1·44 | ·01 | ·07 | 4·0 | 36·8 | 3·33 | Grass, brown. |
| | | Dec., 1934 | ·20 | ·36 | ·09 | 1·65 | ·06 | ·36 | 9·3 | 36·8 | 3·83 | Grass, mainly green. |
| | | Mar., 1935 | ·12 | ·29 | ·16 | 1·47 | trace | ·30 | 6·0 | 36·6 | 3·06 | Grass, green, leafy. |
| | | May, 1935 | ·058 | ·18 | ·05 | ·28 | ·02 | ·07 | 3·8 | 31·0 | 1·32 | Grass, brown, short. |
| Waaihoek........ | Utrecht........ | June, 1934 | ·036 | ·24 | ·12 | ·29 | ·01 | ·08 | 2·3 | 38·9 | 1·43 | Grass, mainly brown. |
| | | Sept., 1934 | ·05 | ·25 | ·08 | ·60 | ·01 | ·14 | 7·1 | 37·1 | 2·03 | Grass, mainly brown, leafy. |
| | | Jan., 1935 | ·19 | ·35 | ·12 | 1·55 | trace | ·48 | 8·5 | 35·3 | 3·58 | Grass, green, leafy. |

## AREA 1 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Frisgewaagd**...... | Utrecht........ | June, 1934 | ·09 | ·41 | ·18 | 1·47 | ·02 | ·07 | 4·4 | 37·4 | 3·54 | Grass, brown. |
| | | Oct., 1934 | ·084 | ·34 | ·19 | ·83 | ·04 | ·31 | 4·2 | 34·8 | 2·68 | Grass, mainly brown, leafy. |
| | | Nov., 1934 | ·26 | ·43 | ·20 | 2·28 | ·06 | ·41 | 14·9 | 27·8 | 5·39 | Grass, green, short. |
| | | Feb., 1935 | ·18 | ·42 | ·08 | 1·36 | ·03 | ·31 | 8·6 | 39·1 | 3·32 | Grass, mainly green, leafy. |
| **Labelle Esperanza** | Paulpietersburg | Nov., 1933 | ·068 | ·16 | ·10 | ·40 | ·01 | ·09 | 4·1 | 36·6 | 1·60 | Grass, mainly brown, short. |
| | | Feb., 1934 | ·11 | ·33 | ·20 | 1·98 | ·13 | ·64 | 7·4 | 37·0 | 3·28 | Grass, mainly green, short. |
| | | May, 1934 | ·059 | ·37 | ·27 | ·61 | trace | ·16 | 4·8 | 36·6 | 2·44 | Grass and shrub ; mostly grass. |
| | | Aug., 1934 | ·049 | ·29 | ·17 | ·24 | trace | ·04 | 3·1 | 35·3 | 1·62 | Grass, mainly brown. |
| | | Nov., 1934 | ·12 | ·49 | ·11 | 1·20 | ·02 | ·20 | 9·0 | 35·0 | 2·60 | Grass, mainly green, leafy. |
| | | Feb., 1935 | ·082 | ·22 | ·10 | ·88 | trace | ·77 | 5·5 | 34·1 | 2·20 | Grass, mainly green, leafy. |
| | | May, 1935 | ·12 | ·32 | ·17 | ·88 | ·03 | ·13 | 5·5 | 33·4 | 2·34 | Grass, leafy. |
| | | Aug., 1935 | ·089 | ·41 | ·26 | ·37 | ·12 | ·14 | 4·2 | 34·4 | 2·40 | Grass, mainly brown, leafy. |
| **Schikhoek**........ | Paulpietersburg | Dec., 1933 | ·13 | ·30 | ·14 | 1·50 | ·04 | ·30 | 6·4 | 37·6 | 3·11 | Grass, mainly green, short. |
| | | Feb., 1934 | ·15 | ·21 | ·13 | 1·59 | ·02 | ·33 | 7·0 | 37·6 | 3·25 | Grass, mainly green. |
| | | June, 1934 | ·055 | ·34 | ·20 | ·41 | ·09 | ·25 | 3·7 | 36·5 | 2·07 | Grass, mainly green, long. |
| | | Sept., 1934 | ·073 | ·36 | ·11 | ·54 | ·02 | ·11 | 5·6 | 36·4 | 1·69 | Grass, mainly brown, leafy. |
| | | Dec., 1934 | ·13 | ·24 | ·14 | 1·93 | ·03 | ·39 | 7·5 | 37·0 | 3·41 | Grass, leafy. |
| | | Mar., 1935 | ·11 | ·53 | ·22 | ·84 | ·03 | ·24 | 6·2 | 36·2 | 3·23 | Grass, mainly green, leafy and bush ; mostly grass. |
| | | June, 1935 | ·11 | ·29 | ·18 | ·78 | ·06 | ·18 | 4·4 | 35 0 | 2·67 | Grass, leafy. |
| | | Sept., 1935 | ·10 | ·46 | ·16 | ·58 | ·04 | ·18 | 4·7 | 35·4 | 2·53 | Grass, mainly brown, leafy. |
| **Knoopaan**....... | Paulpietersburg | Jan., 1934 | ·18 | ·29 | ·16 | 1·66 | ·01 | ·49 | 5·7 | 38·0 | 4·02 | Grass. |
| | | April, 1934 | ·11 | ·27 | ·25 | 1 04 | ·01 | ·56 | 5·1 | 38·8 | 2·99 | Grass. mainly green. |
| | | July, 1934 | ·09 | ·53 | ·40 | ·55 | ·03 | ·17 | 5·8 | 35·9 | 3·28 | Grass. mainly brown. |
| | | Oct., 1934 | ·12 | ·25 | ·16 | 1·00 | ·05 | ·30 | 9·3 | 34·4 | 2·90 | Grass, |
| | | Jan., 1935 | ·10 | ·39 | 23 | 1·42 | ·05 | ·37 | 6·7 | 35·7 | 3·31 | Grass, green, leafy. |
| | | April, 1935 | ·11 | ·33 | ·16 | ·97 | ·04 | ·20 | 6·1 | 33·8 | 3·48 | Grass, mainly green, leafy. |
| | | July, 1935 | ·079 | ·40 | ·22 | ·78 | ·08 | ·19 | 4·6 | 36·3 | 2·51 | Grass, mainly brown, leafy. |
| | | Oct., 1935 | ·14 | ·29 | ·21 | 1·16 | ·06 | ·41 | 8·0 | 32·6 | 3·67 | Grass, mainly green, short. |
| **Bosfontein**....... | Klip River..... | Nov. 1933 | ·17 | ·29 | ·17 | 1·69 | ·10 | ·46 | 12·3 | 34·0 | 3·92 | Grass, mainly green, leafy. |
| | | Feb., 1934 | ·082 | ·31 | ·16 | 1·56 | ·02 | ·31 | 7·3 | 38·8 | 3·75 | Grass, mainly green, leafy. |
| | | May, 1934 | ·12 | ·33 | ·14 | 1·31 | 04 | ·14 | 5·9 | 34·4 | 2·65 | Grass, mainly green, leafy. |
| | | Sept.. 1934 | ·062 | ·37 | ·10 | ·53 | ·02 | ·08 | 6·0 | 33·4 | 1·60 | Grass, leafy. |
| | | Mar.. 1935 | ·082 | ·26 | ·10 | ·86 | trace | 11 | 5·6 | 37·4 | 2·05 | Grass, green, leafy. |
| | | June, 1935 | ·07 | ·37 | ·14 | ·58 | trace | ·22 | 5·1 | 33·6 | 1·99 | Grass, mainly brown, leafy. |
| | | Sept., 1935 | ·063 | 21 | ·04 | ·56 | ·02 | ·15 | 5·2 | 36·3 | 1·51 | Grass, mainly brown, leafy. |
| **Orange Grove**.... | Klip River..... | Dec., 1933 | ·10 | ·27 | ·15 | 1·23 | ·05 | ·29 | 7·4 | 37·2 | 2·81 | Grass, mainly green, leafy. |
| | | Mar., 1934 | ·096 | ·24 | ·15 | 1 18 | 07 | ·25 | 5·3 | 38·5 | 2·30 | Grass, leafy. |
| | | July, 1934 | ·044 | ·36 | ·11 | ·19 | ·01 | ·03 | 2·8 | 35·5 | 1·39 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·088 | ·32 | 10 | ·66 | ·01 | 14 | 6·2 | 35·7 | — | Grass, leafy. |
| | | April, 1935 | ·14 | ·34 | ·15 | ·93 | ·02 | 21 | 4·9 | 32·7 | 2·47 | Grass, green, leafy. |
| | | July, 1935 | ·088 | ·34 | 11 | ·38 | trace | ·14 | 3·2 | 35·7 | 1·78 | Grass, mainly brown, leafy. |

## AREA 1 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mount Plessis.... | Klip River..... | Jan., 1934 | ·091 | ·20 | ·10 | 1·32 | ·04 | ·19 | 7·5 | 39·7 | 2·64 | Grass, mainly green, leafy. |
| | | April, 1934 | ·08 | ·27 | ·12 | 1·01 | ·02 | ·17 | 6·7 | 37·0 | 2·13 | Grass, mainly green, leafy. |
| | | July, 1934 | ·03 | ·22 | ·09 | — | trace | ·02 | 2·9 | 35·9 | 1·05 | Grass, brown, leafy. |
| | | May, 1935 | ·075 | ·39 | ·14 | ·68 | ·04 | ·14 | 4·1 | 33·1 | 2·07 | Grass, short. |
| | | Aug., 1935 | ·046 | ·22 | ·08 | ·34 | ·02 | ·09 | 3·0 | 28·8 | 1·13 | Grass, brown, leafy. |
| Kleinfontein...... | Klip River..... | Dec., 1933 | ·12 | ·26 | ·16 | 1·36 | ·02 | ·29 | 7·3 | 38·0 | 2·91 | Grass, green, leafy. |
| | | Mar., 1934 | ·10 | ·24 | ·12 | 1·00 | ·01 | ·21 | 5·3 | 39·9 | 2·53 | Grass, mainly green. |
| | | May, 1934 | ·06 | ·56 | ·18 | ·69 | ·02 | ·23 | 2·4 | 36·5 | 2·48 | Grass, mainly brown. |
| | | Aug., 1934 | ·03 | ·29 | ·11 | ·12 | trace | ·01 | 2·0 | 38·3 | 1·20 | Grass, brown, leafy. |
| | | Nov., 1934 | ·10 | ·21 | ·11 | ·78 | ·02 | ·14 | 7·1 | 37·3 | 2·07 | Grass, mainly green, leafy. |
| | | Mar., 1935 | ·11 | ·32 | ·10 | ·72 | trace | ·10 | 5·5 | 33·8 | 2·10 | Grass, mainly green, short. |
| | | May, 1935 | ·089 | ·48 | ·19 | ·52 | ·02 | ·09 | 4·2 | 32·0 | 2·32 | Grass, mainly green, leafy. |
| | | July, 1935 | ·06 | ·40 | ·14 | ·20 | trace | ·08 | 2·5 | 33·8 | 1·74 | Grass, brown, leafy. |
| Rietkuil.......... | Klip River..... | Jan., 1934 | ·18 | ·27 | ·15 | 1·54 | ·03 | ·25 | 7·7 | 39·5 | 2·95 | Grass, mainly green. |
| | | June, 1934 | ·10 | ·39 | ·09 | ·43 | ·38 | ·50 | 2·5 | 39·5 | 2·50 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·07 | ·32 | ·08 | ·37 | trace | ·07 | 3·2 | 37·6 | 1·63 | Grass, mainly brown, leafy. |
| | | Jan., 1935 | ·078 | ·39 | ·18 | 1·05 | ·02 | ·17 | 5·8 | 33·8 | 2·72 | Grass, green, leafy. |
| | | April, 1935 | ·14 | ·40 | ·12 | ·90 | ·02 | ·13 | 4·9 | 35·7 | 2·35 | Grass, green, leafy. |
| | | Sept., 1935 | ·069 | ·54 | ·06 | ·20 | trace | ·06 | 3·1 | 33·1 | 1·97 | Grass, brown, leafy. |
| | | Oct., 1935 | ·049 | ·48 | ·05 | ·21 | trace | ·03 | 3·1 | 33·8 | 1·60 | Grass, brown, leafy. |
| Springvalse...... | Klip River..... | Feb., 1934 | ·12 | ·25 | ·14 | 1·50 | trace | ·20 | 5·9 | 40·4 | 3·31 | Grass, mainly green. |
| | | July, 1934 | ·033 | ·34 | ·10 | ·10 | ·01 | ·01 | 2·6 | 38·4 | 1·55 | Grass, brown, leafy. |
| | | Sept., 1934 | ·087 | ·47 | ·14 | ·34 | ·01 | ·07 | 4·4 | 36·5 | 1·89 | Grass, mainly brown, leafy. |
| | | Dec., 1934 | ·15 | ·30 | ·15 | 1·46 | ·03 | ·27 | 6·6 | 36·7 | 2·83 | Grass, mainly green, leafy. |
| | | Feb., 1935 | ·12 | ·38 | ·15 | 1·00 | ·04 | ·14 | 6·0 | 37·1 | 2·34 | Grass, green, leafy. |
| | | June, 1935 | ·074 | ·37 | ·13 | ·28 | trace | ·07 | 2·8 | 36·0 | 1·72 | Grass, brown, short. |
| Davelshoek...... | Klip River..... | Jan., 1934 | ·18 | ·39 | ·23 | 1·90 | ·05 | ·40 | 8·1 | 35·4 | 4·63 | Grass and bush: mostly grass. |
| | | April, 1934 | ·06 | ·37 | ·11 | ·75 | ·01 | ·16 | 5·0 | 39·3 | 2·13 | Grass. |
| Allerpark........ | Klip River..... | Feb., 1934 | ·12 | ·30 | ·23 | 1·41 | ·02 | ·27 | 6·6 | 40·6 | 3·06 | Grass, mainly green. |
| | | May, 1934 | ·074 | ·35 | ·14 | ·41 | ·01 | ·11 | 3·0 | 37·8 | 1·82 | Grass, mainly brown, leafy. |
| Ernevale......... | Klip River..... | Mar., 1934 | ·087 | ·28 | ·11 | ·96 | ·02 | ·20 | 5·5 | 35·9 | 2·39 | Grass, mainly green. |
| | | Oct., 1934 | ·11 | ·33 | ·15 | ·61 | ·02 | ·18 | 5·2 | 39·6 | 2·14 | Grass, long. |
| Horton Radford.. | Bergville....... | Nov., 1933 | ·10 | ·20 | ·12 | ·76 | ·01 | ·22 | 6·2 | 36·9 | 2·11 | Grass. |
| | | Feb., 1934 | ·084 | ·18 | ·18 | 2·07 | ·02 | ·32 | 8·7 | 38·9 | 4·25 | Grass, mainly green. |
| | | May, 1934 | ·042 | ·28 | ·13 | ·92 | trace | ·16 | 3·8 | 37·1 | 1·78 | Grass. |
| | | Oct., 1934 | ·071 | ·24 | ·11 | ·65 | ·01 | ·22 | 4·4 | 38·1 | 2·16 | Grass. |
| | | Nov., 1934 | ·093 | ·21 | ·14 | 1·22 | ·02 | ·27 | 7·0 | 37·3 | 2·56 | Grass, mainly green. |

## AREA 1 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Needwood....... | Bergville....... | Dec., 1933 | ·14 | ·25 | ·14 | 1·38 | ·02 | ·26 | 7·7 | 39·1 | 2·84 | Grass, mainly green, short. |
| | | Mar., 1934 | ·086 | ·22 | ·12 | ·98 | ·01 | ·19 | 5·4 | 40·0 | 2·28 | Grass, mainly green, leafy. |
| | | June, 1934 | ·052 | ·28 | ·11 | ·51 | trace | ·10 | 3·6 | 36·7 | 1·73 | Grass, leafy. |
| | | Oct., 1934 | ·13 | ·25 | ·13 | 1·57 | ·04 | ·37 | 7·0 | 36·5 | 3·18 | Grass, green. |
| Morningside...... | Bergville....... | Jan., 1934 | ·10 | ·29 | ·14 | 1·29 | ·02 | ·20 | 9·6 | 39·0 | 2·82 | Grass, mainly green, leafy. |
| | | April, 1934 | ·065 | ·21 | ·12 | 1·21 | ·01 | ·34 | 6·8 | 37·5 | 2·71 | Grass, mainly green. |
| | | July, 1934 | ·031 | ·26 | ·14 | ·44 | trace | ·10 | 2·8 | 37·0 | 1·52 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·10 | ·24 | ·12 | 1·90 | trace | ·28 | 4·8 | 36·5 | 4·40 | Grass, green. |
| Langkloof No. A.. | Bergville....... | Nov., 1933 | ·16 | ·27 | ·14 | 1·25 | ·01 | ·32 | 8·1 | 36·8 | 2·94 | Grass, short. |
| | | Feb., 1934 | ·18 | ·25 | ·16 | 1·32 | ·02 | ·17 | 7·3 | 40·3 | 2·75 | Grass, mainly green, leafy. |
| | | May, 1934 | ·064 | ·32 | ·13 | ·74 | ·01 | ·23 | 4·8 | 34·4 | 2·20 | Grass, leafy. |
| | | Aug., 1934 | ·036 | ·23 | ·18 | 1·10 | ·02 | ·09 | 4·1 | 40·4 | 2·60 | Grass, mainly brown, leafy. |
| | | Nov., 1934 | ·14 | ·31 | ·16 | 1·31 | ·04 | ·30 | 8·6 | 35·0 | 2·82 | Grass, green, leafy. |
| Second.......... | Bergville....... | Dec., 1933 | ·15 | ·29 | ·16 | 1·15 | ·02 | ·24 | 7·3 | 41·6 | 2·63 | Grass, mainly green. |
| | | Mar., 1934 | ·098 | ·26 | ·11 | 1·14 | ·01 | ·16 | 6·7 | 36·4 | 2·55 | Grass, mainly green, leafy. |
| | | June, 1934 | ·027 | ·26 | ·13 | ·34 | trace | ·05 | 3·0 | 36·8 | 1·29 | Grass, mainly brown,eleafy. |
| | | Sept., 1934 | ·15 | ·21 | ·13 | 1·62 | ·04 | ·39 | 9·2 | 34·5 | 3·30 | Grass, green.. |
| Clifford Chambers | Bergville....... | Jan., 1934 | ·12 | ·22 | ·13 | 1·51 | ·03 | ·31 | 7·7 | 38·2 | 3·08 | Grass, green. |
| | | April, 1934 | ·08 | ·25 | ·15 | 1·07 | ·01 | ·16 | 6·4 | 37·8 | 2·60 | Grass, mainly green, leafy. |
| | | July, 1934 | ·042 | ·36 | ·13 | ·39 | trace | ·14 | 2·1 | 39·6 | 1·70 | Grass, brown, leafy. |
| | | Oct., 1934 | ·13 | ·18 | ·13 | 1·40 | ·04 | ·28 | 8·8 | 35·0 | 2·90 | Grass, green. |
| Tetworth........ | Lions River.... | Nov., 1933 | ·11 | ·16 | ·08 | ·98 | ·05 | ·36 | 6·6 | 43·0 | 2·20 | Grass. |
| | | Feb., 1934 | ·16 | ·23 | ·09 | 1·71 | ·05 | ·48 | 8·2 | 38·2 | 3·79 | Grass, mainly green. |
| | | June, 1934 | ·12 | ·34 | ·10 | 1·55 | ·02 | ·57 | 6·1 | 33·5 | 4·59 | Grass, mainly green, short. |
| | | Oct., 1934 | ·14 | ·24 | ·06 | ·68 | ·04 | ·20 | 7·7 | 33·1 | 3·21 | Grass, mainly green, leafy. |
| | | Jan., 1935 | ·20 | ·62 | ·18 | 4·02 | ·06 | 1·02 | 15·6 | 27·6 | 9·68 | Grass, green, short. |
| | | April, 1935 | ·31 | ·39 | ·26 | 4·27 | ·59 | 1·65 | 18·0 | 26·8 | 9·28 | Grass, mainly green, short. |
| Lee Crofts....... | Lions River.... | Dec., 1933 | ·15 | ·27 | ·12 | 1·42 | ·07 | ·30 | 8·9 | 38·6 | 3·33 | Grass, mainly green, leafy. |
| | | Mar., 1934 | ·15 | ·21 | ·11 | 1·69 | ·06 | ·38 | 8·8 | 36·8 | 3·94 | Grass, mainly green. |
| | | May, 1934 | ·065 | ·28 | ·15 | ·66 | ·03 | ·24 | 5·0 | 38·0 | 2·14 | Grass. |
| | | Nov., 1934 | ·11 | ·23 | ·09 | 1·14 | ·04 | ·24 | 8·8 | 35·7 | 2·54 | Grass, green, leafy. |
| | | Feb., 1935 | ·097 | ·39 | ·09 | 1·45 | ·04 | ·35 | 7·1 | 37·7 | 2·89 | Grass, green, long. |
| | | May, 1935 | ·16 | ·27 | ·09 | 1·65 | ·05 | ·26 | 8·5 | 36·3 | 3·51 | Grass, green, leafy. |
| Shawswood...... | Lions River.... | Jan., 1934 | ·18 | ·21 | ·08 | 1·41 | ·04 | ·29 | 7·3 | 36·7 | 3·13 | Grass, mainly green. |
| | | April, 1934 | ·092 | ·24 | ·08 | ·79 | ·03 | ·18 | 5·2 | 38·0 | 1·71 | Grass, mainly green. |
| | | July, 1934 | ·084 | ·33 | ·10 | ·63 | ·03 | ·17 | 5·3 | 35·4 | 1·85 | Grass, mainly green, leafy. |
| | | Nov., 1934 | ·11 | ·24 | ·09 | 1·45 | ·04 | ·32 | 8·9 | 37·8 | 3·24 | Grass, mainly green, leafy. |
| | | Feb., 1935 | ·15 | ·31 | ·04 | 1·57 | ·06 | ·35 | 5·9 | 38·6 | 3·46 | Grass, mainly green, leafy. |
| | | June, 1935 | ·08 | ·20 | ·06 | ·62 | trace | ·10 | 4·1 | 41·5 | 1·70 | Grass, long. |

AREA 1 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monte Christo No. C | Estcourt....... | Dec., 1933 | ·15 | ·28 | ·17 | 1 42 | ·03 | ·34 | 9·4 | 33·1 | 3·33 | Grass, mainly green. |
| | | Mar., 1934 | ·15 | ·36 | ·18 | 98 | ·02 | ·25 | 6·9 | 31·5 | 2·91 | Grass, mainly green, short. |
| | | June. 1934 | ·07 | ·27 | ·12 | ·56 | ·03 | ·11 | 3·8 | 28·5 | 1·71 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·08 | ·54 | ·10 | 84 | ·02 | ·22 | 5·7 | 34·7 | 2·17 | Grass, mainly green, leafy. |
| | | Dec., 1934 | ·13 | ·28 | ·13 | 1·41 | ·06 | ·25 | 8·2 | 32·5 | 2·92 | Grass, green, leafy. |
| Skurftepoort..... | Estcourt....... | Jan., 1934 | ·13 | ·36 | ·23 | 1·61 | ·03 | ·30 | 11·2 | 34·4 | 3·75 | Grass, green, leafy. |
| | | Mar., 1934 | ·20 | ·28 | ·26 | 2·31 | ·03 | ·41 | 9·9 | 32·5 | 4·42 | Grass, green. short. |
| | | May, 1934 | ·15 | ·38 | ·15 | 1·43 | trace | 52 | 6·2 | 33·5 | 3·39 | Grass, leafy. |
| | | Aug., 1934 | ·038 | ·33 | — | ·38 | ·01 | ·03 | 2·6 | 36·0 | 1·37 | Grass, mainly brown. leafy. |
| | | Nov., 1934 | ·14 | ·34 | ·15 | 1·23 | ·03 | ·25 | 7·0 | 35·8 | 2·89 | Grass, green. leafy. |
| Clouston......... | Estcourt....... | Feb., 1934 | ·11 | ·32 | ·14 | 1·75 | ·06 | ·39 | 7·6 | 36·9 | 3·64 | Grass, mainly green, short. |
| | | April, 1934 | ·16 | ·28 | ·14 | 1·08 | ·04 | ·30 | 7·6 | 32·5 | 2·68 | Grass, mainly green, leafy. |
| | | July, 1934 | ·037 | ·24 | ·09 | ·19 | trace | ·06 | 2·8 | 33·8 | 1·15 | Grass, mainly brown. leafy. |
| | | Oct., 1934 | ·12 | ·28 | ·11 | ·92 | ·02 | ·21 | 5·0 | 34·8 | 2·65 | Grass, mainly green, leafy. |
| | | Jan., 1935 | ·11 | ·31 | ·15 | ·98 | ·09 | ·26 | 6·9 | 30·4 | 2·36 | Grass, green, leafy. |
| Twyfelfontein.... | Estcourt....... | Nov., 1933 | ·15 | ·30 | ·13 | ·96 | ·02 | ·25 | 10·6 | 37·6 | 2·82 | Grass, mainly green, short. |
| | | Mar., 1934 | ·09 | ·36 | ·15 | ·89 | ·02 | ·19 | 4·7 | 35·6 | 2·18 | Grass, green, leafy. |
| | | June, 1934 | ·037 | ·38 | ·11 | ·27 | ·01 | ·07 | 3·0 | 34·3 | 1·68 | Grass, mainly brown. leafy. |
| | | Sept., 1934 | ·082 | ·28 | ·09 | ·54 | trace | ·10 | 5·9 | 34·3 | 1·99 | Grass, leafy. |
| | | April, 1935 | ·06 | ·33 | ·11 | ·47 | ·03 | ·13 | 4·2 | 34·6 | 1·82 | Grass, long. |
| | | July, 1935 | ·052 | ·24 | ·08 | ·30 | ·04 | ·19 | 4·3 | 40·1 | 1·37 | Grass, mainly brown. |
| | | Oct., 1935 | ·09 | ·26 | ·09 | ·81 | ·03 | ·16 | 6·2 | 36·6 | 1·75 | Grass, leafy. |
| Bayonne......... | Estcourt....... | Jan., 1934 | ·13 | ·29 | ·12 | 1·25 | ·02 | ·23 | 7·5 | 35·6 | 2·70 | Grass, mainly green. leafy. |
| | | April, 1934 | ·095 | ·39 | ·15 | ·48 | ·03 | ·16 | 5·7 | 33·6 | 1·92 | Grass, mainly green. leafy. |
| | | July, 1934 | ·044 | ·33 | ·11 | ·33 | trace | ·08 | 3·5 | 36·0 | 1·63 | Grass, brown, leafy. |
| | | Oct., 1934 | ·07 | ·41 | ·09 | ·46 | ·01 | ·08 | 3·8 | 36·8 | 2·00 | Grass, mainly green, leafy. |
| | | Jan., 1935 | ·076 | ·36 | ·14 | ·96 | ·02 | ·16 | 5·3 | 33·9 | 2·18 | Grass, green. leafy. |
| | | May, 1935 | ·11 | ·50 | ·11 | ·45 | ·01 | ·09 | 3·0 | 35·0 | 2·07 | Grass, leafy. |
| Geluksrus........ | Estcourt....... | Feb., 1934 | ·08 | ·34 | ·14 | 1·19 | ·04 | ·28 | 6·3 | 38·8 | 2·72 | Grass, green, leafy. |
| | | May, 1934 | ·062 | ·49 | ·18 | ·98 | ·03 | ·22 | 3·8 | 36·1 | 2·66 | Grass. leafy. |
| | | Nov., 1934 | ·15 | ·30 | ·15 | 1·40 | ·03 | ·36 | 10·0 | 31·9 | 2·90 | Grass, green, leafy. |
| | | Dec., 1934 | ·12 | ·35 | ·14 | 1·01 | ·04 | 20 | 7·4 | 37·5 | 2·33 | Grass. green, leafy. |
| | | June, 1935 | ·056 | ·34 | ·12 | ·28 | trace | ·08 | 2·9 | 34·6 | 1·66 | Grass, mainly brown, leafy. |
| | | Sept., 1935 | ·067 | ·25 | ·10 | ·25 | ·01 | ·08 | 3·7 | 35·6 | 1·68 | Grass. brown, leafy. |
| Meltonleigh...... | Estcourt....... | Nov., 1933 | ·24 | ·27 | ·15 | 2·05 | ·05 | ·40 | 12·1 | 34·4 | 4·29 | Grass, mainly green. |
| | | Feb., 1934 | ·16 | ·23 | ·14 | 1·44 | ·03 | ·26 | 7·1 | 36·1 | 2·97 | Grass, green. |
| | | May, 1934 | ·065 | ·31 | ·15 | ·88 | ·02 | ·18 | 5·5 | 34·8 | 2·14 | Grass, mainly green, leafy. |
| | | Aug., 1934 | ·069 | ·30 | — | ·20 | trace | ·02 | 3·5 | 37·2 | 1·31 | Grass, brown. |
| | | Nov., 1934 | ·071 | ·19 | ·09 | ·92 | ·06 | ·30 | 6·7 | 39·9 | 2·01 | Grass, mainly green, long. |
| | | Jan., 1935 | ·082 | ·27 | ·13 | 1·10 | ·03 | ·31 | 4·9 | 38·0 | 2·45 | Grass, mainly green, long. |
| | | May, 1935 | ·087 | ·27 | ·11 | ·93 | ·03 | ·19 | 4·0 | 35·9 | 2·23 | Grass, mainly green, long. |
| | | Aug., 1935 | ·057 | ·30 | ·11 | ·25 | ·01 | ·07 | 2·4 | 37·3 | 1·58 | Grass, brown, leafy. |

## AREA 1 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Loch Sloy**....... | Estcourt....... | Dec., 1933 | ·12 | ·37 | ·21 | 1·43 | ·02 | ·23 | 6·3 | 38·7 | 3·77 | Grass, mainly green. |
| | | Mar., 1934 | ·073 | ·24 | ·14 | 1·18 | ·02 | ·26 | 4·3 | 41·3 | 2·63 | Grass, mainly green. |
| | | June, 1934 | ·057 | ·27 | ·19 | ·78 | trace | ·16 | 4·4 | 39·1 | 2·09 | Grass, mainly green, long. |
| | | Sept., 1934 | ·038 | ·28 | ·12 | ·25 | ·01 | ·21 | 3·7 | 41·4 | 1·24 | Grass, mainly brown, long. |
| | | Dec., 1934 | ·093 | ·36 | ·14 | ·74 | trace | ·14 | 6·7 | 36·7 | 2·16 | Grass, mainly green, long. |
| | | Mar., 1935 | ·078 | ·19 | ·06 | ·96 | ·02 | ·14 | 6·0 | 39·3 | 1·92 | Grass, mainly green, long. |
| | | June, 1935 | ·055 | ·21 | ·08 | ·55 | trace | ·06 | 3·1 | 39·7 | 1·46 | Grass, brown, leafy. |
| | | Sept., 1935 | ·05 | ·19 | ·04 | ·19 | ·01 | ·06 | 2·9 | 36·5 | 1·06 | Grass, brown, long. |
| **Calcote**.......... | Estcourt....... | Jan., 1934 | ·12 | ·18 | ·10 | 1·61 | ·02 | ·25 | 8·4 | 38·4 | 3·02 | Grass, green. |
| | | April, 1934 | ·20 | ·32 | ·22 | 2·16 | ·56 | ·94 | 8·6 | 35·4 | 6·26 | Grass, green. |
| | | July, 1934 | ·04 | ·26 | ·08 | ·33 | trace | ·11 | 2·7 | 37·0 | 1·64 | Grass, leafy. |
| | | Oct., 1934 | ·07 | ·19 | ·07 | ·55 | ·02 | ·13 | 4·0 | 36·9 | 1·41 | Grass, mainly brown. |
| | | Jan., 1935 | ·21 | ·23 | ·11 | 1·88 | ·08 | ·48 | 10·2 | 35·7 | 4·04 | Grass, green, long. |
| | | April, 1935 | ·097 | ·20 | ·08 | 1·11 | ·05 | ·20 | 6·5 | 34·7 | 2·42 | Grass, mainly green. |
| | | Oct., 1935 | ·055 | ·19 | ·05 | ·17 | ·01 | ·07 | 3·5 | 40·4 | 0·95 | Grass, brown, leafy. |
| **Gretna Green**.... | Weenen........ | Nov., 1933 | ·25 | ·30 | ·18 | 2·25 | ·02 | ·48 | 16·3 | 33·9 | 4·83 | Grass, green, leafy. |
| | | Feb., 1934 | ·08 | ·27 | ·12 | 1·12 | ·03 | ·24 | 7·6 | 35·6 | 2·66 | Grass, green, leafy. |
| | | May, 1934 | — | ·38 | ·16 | ·72 | trace | — | 5·3 | 33·0 | 2·02 | Grass, mainly green, leafy. |
| | | Aug., 1934 | ·065 | ·26 | — | ·23 | trace | ·05 | 3·6 | 36·4 | 1·36 | Grass, mainly brown, leafy. |
| | | Nov., 1934 | ·13 | ·28 | ·15 | 1·21 | ·03 | ·33 | 10·0 | 30·0 | 2·68 | Grass, green, leafy. |
| | | Feb., 1935 | ·15 | ·38 | ·14 | 1·22 | ·02 | ·28 | 7·8 | 32·8 | 2·75 | Grass, green, short. |
| | | May, 1935 | ·092 | ·41 | ·11 | ·44 | ·03 | ·10 | 4·1 | 32·6 | 2·07 | Grass, leafy. |
| | | Aug., 1935 | ·064 | ·30 | 09 | 26 | ·02 | ·07 | 3·2 | 37·5 | 1·51 | Grass, brown, leafy. |
| **Bellevue**......... | Weenen........ | Dec., 1933 | ·13 | ·19 | ·11 | 1·25 | ·05 | ·37 | — | 33·5 | 2·70 | Grass, green. |
| | | Mar., 1934 | ·10 | ·29 | ·15 | 1·04 | ·03 | 27 | 7·8 | 32·9 | 2·46 | Grass, mainly green, leafy. |
| | | June, 1934 | ·05 | ·24 | ·12 | 37 | ·01 | ·08 | 3·8 | 32·8 | 1·44 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·082 | ·39 | ·08 | ·44 | ·04 | ·13 | 5·4 | 36·1 | 1·76 | Grass, mainly brown, leafy. |
| | | Dec., 1934 | 065 | ·22 | ·11 | ·97 | ·02 | ·22 | 5·8 | 33·7 | 1·94 | Grass, green, leafy. |
| | | Mar., 1935 | ·09 | ·41 | ·11 | ·62 | ·05 | ·18 | 5·9 | 33·6 | 2·31 | Grass, green, leafy. |
| | | June, 1935 | ·054 | ·29 | ·11 | ·26 | trace | ·07 | 3·1 | 34·7 | 1·34 | Grass, brown, leafy. |
| | | Sept., 1935 | ·05 | 48 | ·12 | ·26 | ·02 | ·11 | 3·0 | 36·5 | 1·50 | Grass, brown, leafy. |
| **Oribivlakte**....... | Weenen........ | Jan., 1934 | ·098 | ·32 | ·21 | 1·05 | 04 | ·24 | 6·8 | 36·0 | 2·66 | Grass, green, leafy. |
| | | April, 1934 | ·10 | 27 | ·17 | ·96 | ·02 | ·23 | 15·1 | 34·8 | 2·40 | Grass, mainly green, leafy. |
| | | July, 1934 | ·042 | ·37 | ·14 | ·25 | trace | ·07 | 3·1 | 32·6 | 1·68 | Grass, brown, leafy. |
| | | Jan., 1935 | ·092 | 37 | ·15 | ·99 | ·02 | ·24 | 6·2 | 32·6 | 2·25 | Grass, green, leafy. |
| | | April, 1935 | ·073 | ·28 | ·11 | ·64 | ·03 | ·11 | 5·3 | 31·2 | 1·74 | Grass, mainly green, leafy. |
| | | July, 1935 | ·04 | ·27 | ·09 | ·18 | ·02 | ·05 | 2·9 | 34·8 | 1·19 | Grass, brown, leafy. |
| | | Oct., 1935 | ·053 | ·32 | ·09 | 41 | 01 | ·01 | 4·9 | 34·9 | 2·15 | Grass, mainly brown, leafy. |

## AREA 2.

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| U. No. 55....... | Hlabisa........ | Nov., 1933 | ·11 | ·30 | ·15 | ·93 | ·22 | ·53 | 4·2 | 36·8 | 3·35 | Grass. |
| | | May, 1934 | ·03 | ·27 | ·16 | ·33 | ·07 | ·17 | 2·8 | 39·0 | 1·57 | Grass, long. |
| | | June, 1934 | ·05 | ·38 | ·09 | ·39 | ·03 | ·13 | 4·2 | 35·3 | 1·49 | Grass, long. |
| | | Sept., 1934 | ·04 | ·15 | ·12 | ·20 | ·10 | ·17 | 3·0 | 36·5 | 1·15 | Grass, mainly brown. |
| | | Nov., 1934 | ·048 | ·23 | ·11 | ·36 | ·05 | ·11 | 3·2 | 39·2 | 1·48 | Grass, mainly brown, long. |
| | | Feb., 1935 | ·064 | ·20 | ·12 | ·68 | ·10 | ·27 | 4·4 | 38·1 | 1·83 | Grass, mainly green. |
| | | May, 1935 | ·058 | ·27 | ·17 | ·45 | ·07 | ·16 | 3·7 | 34·2 | 3·01 | Grass, |
| | | Aug., 1935 | ·093 | ·33 | ·14 | ·45 | ·10 | ·19 | 3·2 | 37·8 | 2·04 | Grass, mainly brown. |
| U. No. 95....... | Hlabisa........ | Jan., 1934 | ·11 | ·23 | ·15 | 1·22 | ·12 | ·47 | 5·7 | 38·7 | 2·79 | Grass. mainly green. |
| | | May, 1934 | ·047 | ·26 | ·17 | ·37 | ·07 | ·17 | 3·7 | 34·5 | 1·57 | Grass. |
| | | Aug., 1934 | ·085 | ·21 | ·15 | ·87 | ·11 | ·49 | 5·8 | 40·5 | 2·21 | Grass, mainly green, leafy. |
| | | Mar., 1935 | ·05 | ·41 | ·13 | ·29 | ·05 | ·10 | 3·3 | 37·3 | 1·40 | Grass, mainly green. |
| | | July, 1935 | ·062 | ·28 | ·12 | ·28 | ·06 | ·15 | 3·2 | 40·4 | 1·31 | Grass, leafy. |
| | | Oct., 1935 | ·057 | ·19 | ·11 | ·19 | ·10 | ·08 | 2·9 | 36·4 | 1·17 | Grass, mainly brown, leafy. |
| U. No. 67....... | Hlabisa........ | Jan., 1934 | ·057 | ·17 | ·13 | ·67 | ·10 | ·20 | 5·7 | 41·6 | 1·71 | Grass. |
| | | Mar., 1934 | ·066 | ·15 | ·13 | ·83 | ·15 | ·31 | 4·8 | 42·3 | 2·03 | Grass. |
| | | April, 1935 | ·069 | ·20 | ·16 | ·59 | ·10 | ·21 | 4·2 | 35·3 | 2·04 | Grass, leafy. |
| | | June. 1935 | ·052 | ·26 | ·10 | ·28 | ·03 | ·09 | 3·4 | 38·6 | 1·55 | Grass, mainly brown, leafy. |
| Gwedhla No. 669. | Hlabisa........ | Nov.. 1933 | ·06 | ·39 | ·12 | ·53 | ·04 | ·14 | 4·4 | 41·8 | 1·98 | Grass. mainly brown. |
| | | Feb., 1934 | ·23 | ·31 | ·14 | 1·62 | ·41 | ·31 | 11·1 | 32·3 | 4·56 | Grass. mainly green, short. |
| | | May. 1934 | ·26 | ·55 | ·34 | 2·25 | ·77 | 2·08 | 8·3 | 32·1 | 7·64 | Grass. |
| | | Aug.. 1934 | ·19 | ·59 | ·48 | ·68 | ·79 | 1·31 | 11·5 | 34·4 | 6·40 | Grass, mainly green. |
| | | Nov., 1934 | ·24 | ·48 | ·44 | 3·33 | 1·07 | 1·24 | 18·0 | 29·1 | 8·36 | Grass. green. leafy. |
| | | Feb., 1935 | ·10 | ·26 | ·14 | ·84 | ·12 | ·16 | 4·9 | 36·3 | 2·26 | Grass, mainly green, long. |
| | | May. 1935 | ·075 | ·21 | ·07 | ·50 | ·08 | ·09 | 3·5 | 37·9 | 1·56 | Grass, mainly brown. |
| | | Aug., 1935 | ·22 | ·28 | ·19 | 1·36 | ·12 | ·33 | 11·1 | 31·0 | 3·56 | Grass, mainly green, leafy. |
| Nyalazi No. 520.. | Hlabisa........ | Dec., 1933 | ·16 | ·24 | ·17 | 1·12 | ·36 | ·48 | 4·9 | 38·2 | 3·44 | Grass, short. |
| | | Mar., 1934 | ·32 | ·32 | ·21 | 1·78 | ·19 | 1·23 | 10·7 | 36·1 | 5·22 | Grass, mainly green, short. |
| | | June. 1934 | ·23 | ·73 | ·32 | 2·01 | 1·22 | 2·19 | 14·8 | 30·8 | 8·62 | Grass. mainly green, leafy. |
| | | Sept., 1934 | ·19 | ·75 | ·37 | 2·22 | 1·02 | 1·97 | 15·0 | 30·3 | 8·56 | Grass. green, leafy. |
| | | Dec., 1934 | ·087 | ·26 | ·14 | 1·20 | ·15 | ·48 | 7·5 | 35·0 | 3·09 | Grass. green. leafy. |
| | | Mar., 1935 | ·098 | ·26 | ·11 | ·46 | ·10 | ·16 | 3·8 | 36·3 | 2·06 | Grass, mainly brown, leafy. |
| | | June. 1935 | ·18 | ·30 | ·26 | 1·73 | 1·40 | 2·92 | 13·7 | 35·8 | 8·12 | Grass. mainly green. leafy. |
| | | Sept.. 1935 | ·10 | ·68 | ·23 | 1·07 | ·35 | 1·33 | 6·1 | 38·0 | 3·59 | Grass, mainly green. |
| Hoho No. 522.... | Hlabisa........ | Jan.. 1934 | ·28 | ·28 | ·28 | 2·59 | ·35 | 1·08 | 13·4 | 31·6 | 6·52 | Grass, short. |
| | | April, 1934 | ·19 | ·35 | ·16 | 1·40 | ·43 | ·77 | 6·3 | 34·1 | 4·45 | Grass. mainly green. |
| | | July. 1934 | ·15 | ·29 | ·17 | ·82 | ·28 | ·67 | 5·4 | 36·6 | 3·20 | Grass. |
| | | Oct., 1934 | ·18 | ·86 | ·31 | 1·91 | 1·12 | 2·24 | 11·4 | 28·7 | 8·60 | Grass. green, leafy. |
| | | Jan., 1935 | ·078 | ·31 | ·13 | ·63 | ·05 | ·25 | 5·2 | 34·2 | 2·56 | Grass, mainly green, leafy. |
| | | April, 1935 | ·15 | ·30 | ·16 | 1·17 | ·47 | ·71 | 9·9 | 34·0 | 4·45 | Grass, mainly green, leafy. |
| | | July, 1935 | ·26 | ·89 | ·33 | 2·01 | ·78 | 1·39 | 16·6 | 29·4 | 8·00 | Grass, green, leafy. |
| | | Oct., 1935 | ·18 | ·19 | ·18 | 1·19 | ·60 | 1·13 | 6·4 | 42·3 | 4·51 | Grass. |

## AREA 2 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mfembeni No. T.A. 528 | Hlabisa........ | Nov., 1933 | ·13 | ·26 | ·18 | ·64 | ·07 | ·23 | 4·9 | 38·8 | 2·10 | Grass. |
| | | Feb., 1934 | ·076 | ·27 | ·16 | 1·00 | ·14 | ·28 | 5·0 | 37·0 | 2·59 | Grass, mainly green. |
| | | May, 1934 | ·052 | ·27 | ·16 | ·55 | ·06 | ·26 | 6·2 | 36·1 | 2·22 | Grass, mainly green, leafy. |
| | | Aug., 1934 | ·11 | ·28 | ·17 | ·85 | ·12 | ·34 | 6·5 | 38·0 | 2·56 | Grass, mainly green, long. |
| | | Nov., 1934 | ·13 | ·26 | ·16 | 1·62 | ·18 | ·54 | 9·9 | 35·7 | 3·55 | Grass, mainly green, long. |
| | | Feb., 1935 | ·079 | ·38 | ·20 | ·69 | ·05 | ·17 | 5·2 | 36·9 | 2·29 | Grass, green, long. |
| | | May, 1935 | ·061 | ·28 | ·09 | ·31 | ·04 | ·10 | 3·1 | 35·2 | 1·78 | Grass, mainly brown, leafy. |
| | | Aug., 1935 | ·052 | ·29 | ·11 | ·20 | ·03 | ·09 | 2·9 | 37·6 | 1·63 | Grass, mainly brown, leafy |
| Tank Area No. 524 | Hlabisa........ | Dec., 1933 | ·12 | ·31 | ·22 | 1·44 | ·20 | ·53 | 6·5 | 39·0 | 3·70 | Grass. |
| | | Mar., 1934 | ·078 | ·35 | ·20 | ·71 | ·10 | ·31 | 4·6 | 37·7 | 2·62 | Grass. |
| | | June, 1934 | ·057 | ·36 | ·20 | ·63 | ·07 | ·47 | 4·4 | 35·7 | 2·62 | Grass, mainly green, long. |
| | | Sept., 1934 | ·11 | ·29 | ·14 | 1·01 | ·13 | ·31 | 8·2 | 35·5 | 2·80 | Grass, mainly green, long. |
| | | Dec., 1934 | ·14 | ·28 | ·17 | 1·62 | ·15 | ·36 | 8·5 | 36·4 | 3·47 | Grass, leafy. |
| | | Mar., 1935 | ·065 | ·36 | ·20 | ·50 | ·03 | ·09 | 4·8 | 36·0 | 1·91 | Grass, green, long. |
| | | June, 1935 | ·041 | ·26 | ·07 | ·25 | trace | ·07 | 2·8 | 38·4 | 1·56 | Grass, mainly brown, leafy. |
| | | Sept., 1935 | ·049 | ·25 | ·10 | ·18 | ·09 | ·22 | 3·0 | 39·8 | 1·44 | Grass, mainly brown. |
| Buscedeni No. T.A. 529 | Nongoma...... | Jan., 1934 | ·17 | ·22 | ·15 | 1·36 | ·04 | ·31 | 5·2 | 39·8 | 2·77 | Grass. |
| | | April, 1934 | ·047 | ·31 | ·21 | ·69 | ·07 | ·22 | 4·0 | 38·4 | 2·17 | Grass. |
| | | July, 1934 | ·06 | ·20 | ·14 | ·62 | ·11 | ·33 | 5·6 | 37·8 | 1·97 | Grass, mainly green, long. |
| | | Oct., 1934 | ·12 | ·24 | ·16 | 1·20 | ·16 | ·40 | 9·2 | 34·7 | 3·00 | Grass, mainly green, long. |
| | | Jan., 1935 | ·085 | ·34 | ·22 | ·66 | ·05 | ·22 | 5·0 | 35·9 | 2·22 | Grass, green, long. |
| | | April, 1935 | ·039 | ·33 | ·09 | ·37 | ·04 | ·14 | 3·1 | 33·6 | 1·71 | Grass, long. |
| | | July, 1935 | ·052 | ·26 | ·12 | ·20 | ·04 | ·08 | 3·3 | 33·1 | 1·33 | Grass, mainly brown, leafy. |
| | | Oct., 1935 | ·053 | ·24 | ·10 | ·32 | ·05 | ·10 | 4·4 | 40·9 | 1·52 | Grass, mainly brown, leafy. |
| Elgin............ | Ubombo....... | Dec., 1933 | ·25 | ·44 | ·20 | 1·27 | ·39 | ·91 | 9·2 | 30·4 | 5·42 | Grass, mainly green. |
| | | Mar., 1934 | ·087 | ·31 | ·13 | ·88 | ·18 | ·37 | 5·7 | 42·5 | 2·55 | Grass, mainly green. |
| | | Sept., 1934 | ·071 | ·30 | ·17 | ·58 | ·04 | ·12 | 4·9 | 36·8 | 1·81 | Grass, mainly brown. |
| | | Aug., 1935 | ·058 | ·26 | ·08 | ·20 | ·08 | ·13 | 1·8 | 43·2 | 1·41 | Grass, brown. |
| Mandhlaga....... | Ubombo....... | Jan., 1934 | ·10 | ·31 | ·16 | ·91 | ·12 | ·34 | 5·1 | 38·6 | 2·77 | Grass, mainly green. |
| | | April, 1934 | ·087 | ·24 | ·13 | ·74 | ·08 | ·34 | 4·3 | 34·1 | 2·24 | Grass, mainly brown. |
| | | July, 1934 | ·06 | ·33 | ·13 | ·28 | ·11 | ·20 | 2·4 | 39·2 | 1·73 | Grass, brown. |
| | | Oct., 1934 | ·06 | ·15 | ·11 | ·33 | ·11 | ·18 | 3·3 | 35·7 | 1·41 | Grass, mainly brown. |
| | | Dec., 1934 | ·096 | ·27 | ·16 | 1·10 | ·20 | ·57 | 6·7 | 36·2 | 2·88 | Grass, mainly green. |
| | | April, 1935 | ·083 | ·29 | ·14 | ·88 | ·10 | ·29 | 4·0 | 35·5 | 2·44 | Grass, mainly green, leafy. |
| | | July, 1935 | ·085 | ·35 | ·14 | ·54 | ·05 | ·24 | 4·0 | 37·8 | 1·93 | Grass, mainly brown, leafy. |
| | | Oct., 1935 | ·11 | ·23 | ·29 | ·72 | ·55 | 1·10 | 4·3 | 45·4 | 3·65 | Grass, brown, long. |
| Quest........... | Ubombo....... | Feb., 1934 | ·13 | ·29 | ·15 | 1·74 | ·18 | ·64 | 7·4 | 36·4 | 4·06 | Grass, mainly green. |
| | | May, 1934 | ·21 | ·27 | ·22 | 1·32 | ·17 | ·59 | 6·9 | 37·3 | 3·61 | Grass. |
| | | Aug., 1934 | ·079 | ·19 | ·14 | ·67 | ·11 | ·30 | 3·6 | 40·2 | 1·98 | Grass, mainly brown. |
| | | Nov., 1934 | ·086 | ·30 | ·14 | ·77 | ·08 | ·31 | 3·9 | 37·1 | 2·53 | Grass. |
| | | Jan., 1935 | ·20 | ·24 | ·21 | 2·40 | ·43 | 1·21 | 10·4 | 34·1 | 5·66 | Grass, mainly green, leafy. |
| | | May, 1935 | ·089 | ·24 | ·09 | ·69 | ·04 | ·10 | 4·0 | 34·8 | 1·82 | Grass, leafy. |
| | | Sept., 1935 | ·04 | ·22 | ·04 | ·15 | ·09 | ·15 | 2·1 | 37·9 | 1·37 | Grass, brown. |

AREA 2 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H. No. 40....... | Hlabisa........ | Dec., 1933 | ·21 | 47 | ·19 | 3·47 | ·33 | ·64 | 11·8 | 27·7 | 6·93 | Grass, green and bush; mostly grass. |
| | | Mar., 1934 | ·17 | ·26 | ·17 | 2·40 | ·57 | 1·17 | 7·5 | 39·1 | 5·58 | Grass, mainly green, long. |
| | | June, 1934 | ·15 | 27 | ·25 | 1·78 | ·31 | ·77 | 6·5 | 32·3 | 4·87 | Grass, long. |
| | | Sept., 1934 | ·054 | 23 | ·22 | ·47 | ·12 | ·21 | 3·9 | 34 5 | 2·21 | Grass, mainly brown. |
| | | Dec., 1934 | ·13 | ·15 | ·11 | ·33 | ·08 | ·09 | 2·8 | 39·8 | 1·38 | Grass, long. |
| | | Mar., 1935 | ·06 | ·21 | ·16 | ·66 | ·05 | ·19 | 3·3 | 37·3 | 1·87 | Grass, mainly green, long. |
| | | June, 1935 | ·076 | ·29 | ·08 | ·41 | ·03 | ·11 | 2·8 | 40·9 | 1·57 | Grass, brown, long. |
| H. No. 29....... | Hlabisa........ | Jan., 1934 | ·13 | ·29 | ·19 | 1·89 | ·39 | 1·11 | 6·0 | 40·2 | 4·92 | Grass. |
| | | April, 1934 | ·15 | ·31 | ·17 | 1·19 | ·11 | ·41 | 6·9 | 35·8 | 3·07 | Grass, mainly green, leafy. |
| | | July, 1934 | ·18 | ·31 | ·24 | ·80 | ·26 | ·60 | 4·8 | 36·1 | 3·24 | Grass, mainly brown, long. |
| | | Oct., 1934 | ·073 | ·17 | ·19 | ·54 | ·20 | ·39 | 3 5 | 38·0 | 2·23 | Grass, brown, long. |
| | | April, 1935 | ·13 | ·25 | ·15 | ·86 | ·28 | ·42 | 4·1 | 37·7 | 3·05 | Grass, mainly brown, long. |
| | | July, 1935 | ·078 | ·15 | ·09 | ·29 | ·06 | ·11 | 3·1 | 39·1 | 1·19 | Grass, brown, long. |
| | | Sept., 1935 | ·056 | ·42 | ·22 | ·34 | ·35 | ·65 | 3·2 | 39·3 | 2·65 | Grass, brown, long. |
| No. H. 13....... | Hlabisa........ | Feb., 1934 | ·13 | ·19 | ·13 | 1·41 | ·09 | 42 | 5·4 | 40·7 | 3·52 | Grass, mainly green. |
| | | May, 1934 | ·14 | ·37 | ·12 | ·44 | ·07 | ·13 | 3·0 | 39·1 | 2·10 | Grass, long. |
| | | Aug., 1934 | ·078 | ·23 | ·11 | ·30 | ·08 | ·11 | 3·4 | 36·7 | 1·55 | Grass, brown, long. |
| | | Nov., 1934 | ·10 | ·21 | ·11 | ·40 | ·06 | ·08 | 2·2 | 42·9 | 1·59 | Grass, brown, long. |
| | | Feb., 1935 | ·13 | ·27 | ·25 | 1·69 | ·21 | ·43 | 6·6 | 35·4 | 4·11 | Grass, mainly green, long. |
| | | May, 1935 | ·12 | ·28 | ·17 | 1·01 | ·22 | ·30 | 3·9 | 36·1 | 2·45 | Grass, mainly brown, long. |
| | | Aug., 1935 | ·074 | ·26 | ·11 | ·22 | ·05 | ·09 | 2·2 | 37·0 | 1·12 | Grass, brown, long. |
| | | Oct., 1935 | ·067 | ·19 | ·09 | ·29 | ·13 | ·16 | 3·5 | 38·2 | 1·31 | Grass, brown. |
| Pongola No. T.A. 516 | Ubombo....... | Jan., 1934 | ·10 | ·30 | ·22 | 1·58 | ·29 | ·70 | 6·4 | 37·9 | 3 94 | Grass, mainly green. |
| | | April, 1934 | ·075 | ·26 | ·13 | 1·02 | ·18 | ·34 | 4·3 | 40·2 | 2·42 | Grass, long. |
| | | July, 1934 | ·079 | ·27 | ·10 | ·41 | ·04 | ·15 | 5·0 | 38·8 | 1·62 | Grass, mainly brown, long. |
| | | Sept., 1934 | ·12 | ·14 | ·21 | ·70 | ·25 | ·48 | 5·0 | — | 2·50 | Grass, mainly brown, long. |
| | | Nov., 1934 | ·071 | ·23 | ·10 | ·70 | ·04 | ·24 | 4·3 | 40·3 | 1·80 | Grass, mainly brown, long. |
| | | Feb., 1935 | ·15 | ·27 | ·31 | 2·02 | ·69 | ·80 | 6 4 | 38·3 | 5 82 | Grass, mainly green, long. |
| | | May, 1935 | ·25 | ·26 | ·32 | 2·36 | ·56 | ·61 | 6·8 | 37·6 | 6·16 | Grass, long. |
| | | Aug., 1935 | ·054 | ·21 | ·08 | ·19 | ·05 | ·12 | 2·2 | 39·4 | 1·27 | Grass, brown, long. |
| Maraba No. T.A. 500 | Ubombo....... | Feb., 1934 | ·097 | ·21 | ·10 | ·79 | ·06 | ·25 | 2·4 | 40·8 | 2·05 | Grass. |
| | | May, 1934 | ·047 | ·38 | ·10 | ·47 | ·05 | ·29 | 2·7 | 44·0 | 1·79 | Grass, long. |
| | | Aug., 1934 | ·12 | ·26 | ·08 | ·35 | ·04 | ·08 | 3·3 | 40·9 | 1·52 | Grass, mainly brown, long. |
| | | Dec., 1934 | ·066 | ·27 | ·07 | ·60 | ·07 | ·17 | 4·8 | 35·6 | 1·69 | Grass, long. |
| | | Mar., 1935 | ·12 | ·56 | ·23 | 1·45 | ·22 | ·68 | 5·7 | 38·5 | 3·57 | Grass, mainly green, long. |
| | | June, 1935 | ·08 | ·40 | ·24 | ·89 | ·02 | ·27 | 2·6 | 40·2 | 2·40 | Grass, long. |
| | | Sept., 1935 | ·09 | ·19 | ·08 | ·35 | ·09 | ·18 | 1·9 | 44·1 | 1·53 | Grass, brown, long. |

## AREA 2 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mseleni No. T.A. 512 | Ubombo....... | Mar., 1934 | ·11 | ·27 | ·17 | 1·19 | ·57 | ·75 | 5·9 | 41·4 | 3·39 | Grass. |
| | | June, 1934 | ·18 | ·37 | ·19 | ·84 | ·18 | ·28 | 4·9 | 39·3 | 3·04 | Grass, mainly green, long. |
| | | Oct., 1934 | ·18 | ·14 | ·23 | ·58 | ·45 | ·89 | 3·2 | 44·1 | 3·00 | Grass, brown, long. |
| | | Jan., 1935 | ·19 | ·38 | ·19 | 1·24 | ·31 | ·69 | 5·2 | 38·9 | 3·71 | Grass, mainly green, long. |
| | | April, 1935 | ·06 | ·39 | ·35 | ·87 | ·05 | ·22 | 3·2 | 36·8 | 2·75 | Grass, mainly brown. |
| | | July, 1935 | ·17 | ·31 | ·22 | 1·31 | ·33 | ·82 | 7·8 | 40·9 | 4·17 | Grass, mainly green, long. |
| Waterton Estates, Lot No. K. 11 | Lower Umfolosi | Nov., 1933 | ·13 | ·33 | ·13 | 1·10 | ·02 | ·18 | 8·3 | 30·8 | 3·29 | Grass, short. |
| | | Feb., 1934 | ·14 | ·19 | ·11 | 1·38 | ·35 | ·62 | 5·3 | 38·4 | 3·69 | Grass, mainly green. |
| | | April, 1934 | ·058 | ·21 | ·13 | ·68 | ·11 | ·28 | 5·0 | 37·6 | 2·01 | Grass, mainly green. |
| | | May, 1935 | ·097 | ·44 | ·16 | ·61 | ·14 | ·10 | 4·9 | 34·3 | 2·59 | Grass, mainly brown, leafy. |
| | | June, 1935 | ·039 | ·24 | ·11 | ·27 | trace | ·08 | 3·1 | 36·9 | 1·30 | Grass, leafy. |
| | | Sept., 1935 | ·085 | ·38 | ·18 | ·62 | ·30 | ·24 | 5·0 | 38·0 | 3·03 | Grass, mainly brown. |
| Sokulu No. T.A. 615 | Lower Umfolosi | Dec., 1933 | ·11 | ·21 | ·14 | 1·43 | ·34 | ·63 | 7·1 | 33·6 | 3·62 | Grass, mainly green, short. |
| | | Mar., 1934 | ·094 | ·24 | ·14 | 1·14 | ·22 | ·39 | 6·2 | 35·7 | 2·91 | Grass, mainly green. |
| | | May, 1934 | ·055 | ·22 | ·16 | ·62 | ·11 | ·29 | 4·7 | 38·8 | 1·93 | Grass. |
| No. T.A. 614.... | Lower Umfolosi | Jan., 1934 | ·11 | ·26 | ·15 | ·98 | ·23 | ·36 | 5·8 | 35·6 | 2·84 | Grass, short. |
| | | July, 1935 | ·075 | ·27 | ·13 | ·59 | ·06 | ·13 | 3·7 | 41·5 | 1·89 | Grass, mainly brown. |
| Lot No. 35...... | Nkandhla...... | Nov., 1933 | ·074 | ·22 | ·11 | ·45 | ·04 | ·13 | 5·0 | 37·5 | 1·78 | Grass, short. |
| | | Feb., 1934 | ·093 | ·27 | ·16 | 1·04 | ·03 | ·24 | 6·3 | 37·5 | 2·53 | Grass. |
| | | May, 1934 | ·052 | ·22 | ·13 | ·57 | ·01 | ·13 | 4·4 | 37·4 | 1·82 | Grass, leafy. |
| | | Aug., 1934 | ·036 | ·22 | ·10 | ·41 | ·01 | ·05 | 2·6 | 36·9 | 1·22 | Grass, mainly brown, leafy. |
| | | Nov., 1934 | ·11 | ·25 | ·10 | 1·13 | ·08 | ·43 | 8·4 | 39·0 | 2·62 | Grass, mainly green. |
| | | Feb., 1935 | ·074 | ·18 | ·11 | ·83 | ·04 | ·12 | 4·0 | 39·7 | 1·78 | Grass, green, long. |
| | | May, 1935 | ·073 | ·40 | ·20 | ·44 | ·04 | ·12 | 4·0 | 34·3 | 2·10 | Grass, mainly green, leafy. |
| | | Aug., 1935 | ·052 | ·16 | ·07 | ·35 | ·04 | ·09 | 2·1 | 46·8 | 1·18 | Grass, brown. |
| Nkandhla Village | Nkandhla...... | Dec., 1933 | ·084 | ·38 | ·10 | ·60 | ·05 | ·28 | 6·0 | 40·5 | 2·68 | Grass. |
| | | Mar., 1934 | ·065 | ·15 | ·08 | ·79 | ·04 | ·17 | 7·5 | 41·5 | 1·81 | Grass, mainly green. |
| | | June, 1934 | ·087 | ·19 | ·10 | ·47 | ·03 | ·12 | 3·3 | 38·5 | 1·37 | Grass. |
| | | Oct., 1934 | ·065 | ·21 | ·08 | ·39 | ·04 | ·10 | 4·4 | 41·4 | — | Grass. |
| | | Dec., 1934 | ·092 | ·26 | ·14 | ·91 | ·14 | ·22 | 7·5 | 38·7 | 1·84 | Grass, green, long. |
| | | April, 1935 | ·077 | ·26 | ·13 | ·69 | ·09 | ·15 | 5·4 | 37·1 | 1·92 | Grass, green, long. |
| | | July, 1935 | ·046 | ·24 | ·16 | ·14 | ·03 | ·10 | 2·3 | 39·2 | 1·44 | Grass, brown. |
| | | Sept., 1935 | ·052 | ·30 | ·11 | ·19 | ·04 | ·07 | 3·2 | 38·0 | 1·41 | Grass, brown, leafy. |
| Mpandhleni T.A.. | Nkandhla...... | Jan., 1934 | ·12 | ·27 | ·15 | 1·38 | ·09 | ·29 | 9·2 | 37·0 | 3·14 | Grass, mainly green. |
| | | April, 1934 | ·083 | ·19 | ·12 | ·79 | ·04 | ·17 | 5·5 | 40·5 | 1·86 | Grass, mainly green. |
| | | July, 1934 | ·04 | ·21 | ·06 | ·35 | ·01 | ·06 | 4·8 | 37·1 | 1·46 | Grass. |
| | | Sept., 1934 | ·044 | ·20 | ·09 | ·11 | ·05 | ·04 | 5·4 | 38·1 | 1·07 | Grass, mainly brown. |
| | | Jan., 1935 | ·062 | ·19 | ·09 | ·53 | ·06 | ·13 | 4·5 | 42·0 | 1·40 | Grass, mainly green, long. |
| | | Mar., 1935 | ·08 | ·12 | ·10 | ·97 | ·07 | ·26 | 5·1 | 38·5 | 2·36 | Grass, green, long. |
| | | June, 1935 | ·05 | ·19 | ·09 | ·17 | trace | ·08 | 3·0 | 38·5 | 1·16 | Grass. |
| | | Oct., 1935 | ·045 | ·19 | ·07 | ·17 | ·01 | ·03 | 3·6 | 39·4 | 1·17 | Grass, brown, leafy. |

AREA 2 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Glen, Marvel..... | Nkandhla...... | Nov., 1933 | ·21 | ·38 | ·12 | 1·77 | ·08 | ·50 | 10·3 | 36·9 | 4·51 | Grass, mainly green, leafy. |
| | | Feb., 1934 | ·20 | ·22 | ·09 | 1·26 | ·06 | ·22 | 6·8 | 38·4 | 2·91 | Grass, mainly green. |
| | | May, 1934 | ·16 | — | ·10 | 1·01 | ·03 | ·25 | 5·0 | 39·3 | 2·45 | Grass. |
| | | Aug., 1934 | ·068 | ·24 | ·09 | ·45 | ·01 | ·06 | 2·5 | 43·3 | 1·51 | Grass, mainly brown. |
| | | Jan., 1935 | ·22 | ·27 | ·14 | 1·80 | ·07 | ·24 | 8·0 | 38·0 | 3·55 | Grass, mainly green, leafy. |
| | | Feb., 1935 | ·25 | ·30 | ·19 | 1·92 | ·15 | ·70 | 7·6 | 34·6 | 4·45 | Grass, green, long. |
| | | April, 1935 | ·13 | ·25 | ·13 | ·56 | ·03 | ·18 | 4·3 | 34·8 | 2·39 | Grass, mainly green, long. |
| | | Aug., 1935 | ·098 | ·29 | ·12 | ·41 | ·03 | ·13 | 3·0 | 39·1 | 1·77 | Grass, mainly brown. |
| Mfongosi......... | Nkandhla...... | Dec., 1933 | ·21 | ·40 | ·18 | 2·69 | ·13 | ·85 | 15·7 | 35·5 | 5·54 | Grass, green, leafy. |
| | | Mar., 1934 | ·14 | ·73 | ·26 | ·85 | ·07 | ·28 | 9·3 | 31·5 | 3·58 | Grass, mainly green and bush; mostly grass. |
| | | June, 1934 | ·084 | ·25 | ·10 | ·85 | ·02 | ·22 | 3·6 | 38·3 | 2·13 | Grass. |
| | | Sept., 1934 | ·033 | ·15 | ·11 | ·03 | trace | ·01 | 3·1 | 42·4 | 0·94 | Grass, brown. |
| | | Dec., 1934 | ·17 | ·33 | ·16 | 1·14 | ·05 | ·26 | 7·3 | 38·8 | 2·70 | Grass, green. |
| | | Mar., 1935 | ·23 | ·32 | ·17 | 1·29 | ·08 | ·37 | 7·5 | 33·3 | 3·44 | Grass, mainly green. |
| | | June, 1935 | ·14 | ·41 | ·31 | 1·06 | ·19 | ·62 | 7·0 | 35·6 | 3·67 | Grass, mainly green. |
| | | Sept., 1935 | ·10 | ·46 | ·11 | ·37 | ·05 | ·17 | 3·1 | 42·1 | 1·78 | Grass, brown. |
| Nhloshane....... | Nkandhla...... | Jan., 1934 | ·21 | ·38 | ·14 | 1·94 | ·07 | ·39 | 8·3 | 35·8 | 4·06 | Grass, mainly green, leafy. |
| | | April, 1934 | ·16 | ·36 | ·12 | 1·09 | ·12 | ·29 | 7·8 | 35·0 | 2·68 | Grass, mainly green, leafy. |
| | | July, 1934 | ·12 | ·34 | ·15 | ·59 | ·05 | ·23 | 3·7 | 37·8 | 2·02 | Grass, mainly brown. |
| | | Oct., 1934 | ·29 | ·32 | ·25 | 2·03 | ·07 | ·63 | 10·7 | 32·6 | 4·55 | Grass, mainly green, leafy. |
| | | Mar., 1935 | ·24 | ·32 | ·12 | ·84 | ·04 | ·14 | 6·5 | 33·8 | 2·72 | Grass, mainly green, leafy. |
| | | May, 1935 | ·19 | ·37 | ·18 | 1·13 | ·04 | ·18 | 6·7 | 31·9 | 3·40 | Grass, short. |
| | | July, 1935 | ·13 | ·38 | ·17 | ·98 | ·09 | ·49 | 5·2 | 26·0 | 3·34 | Grass, leafy. |
| | | Oct., 1935 | ·12 | ·24 | ·10 | ·42 | ·02 | ·05 | 3·2 | 40·5 | 1·76 | Grass, brown. |
| No. T.A. 628.... | Mtunzini....... | Dec., 1933 | ·072 | ·39 | ·13 | 1·05 | ·29 | ·47 | 4·9 | 38·9 | 3·03 | Grass, short. |
| | | May, 1934 | ·048 | ·23 | ·18 | ·59 | ·18 | ·34 | 3·7 | 37·4 | 2·25 | Grass. |
| | | Aug., 1934 | ·045 | ·22 | ·13 | ·39 | ·03 | ·11 | 3·5 | 38·1 | 1·61 | Grass, mainly brown. |
| | | Oct., 1934 | ·037 | ·14 | ·15 | ·57 | ·22 | ·49 | 4·2 | 33·1 | 2·00 | Grass. |
| | | Feb., 1935 | ·058 | ·34 | ·16 | ·75 | ·09 | ·16 | 4·5 | 36·7 | 2·31 | Grass, mainly green. |
| Amatikulu No. T.A. 627 | Mtunzini....... | June, 1934 | ·043 | ·15 | ·07 | ·27 | ·04 | ·07 | 4·7 | 39·0 | 1·16 | Grass. |
| | | Nov., 1934 | ·054 | ·15 | ·15 | ·38 | ·17 | ·35 | 3·2 | 34·7 | 1·75 | Grass. |
| Enkwaleni No. T.A. | Entonjaneni.... | Dec., 1933 | ·15 | ·56 | ·24 | 2·42 | ·34 | ·36 | 13·2 | 34·3 | 5·89 | Grass, leafy. |
| | | Mar., 1934 | ·083 | ·18 | ·08 | ·90 | ·07 | ·18 | 5·2 | 33·8 | 2·31 | Grass, mainly green. |
| | | Sept., 1934 | ·10 | ·19 | ·18 | ·71 | ·19 | ·34 | 7·4 | 35·2 | 2·41 | Grass, mainly green, leafy. |
| | | May, 1935 | ·069 | ·47 | ·16 | ·43 | ·04 | ·11 | 4·1 | 35·2 | 2·16 | Grass, leafy and bush; mostly grass. |
| | | Aug., 1935 | ·056 | ·17 | ·15 | ·26 | ·04 | ·11 | 2·3 | 38·3 | 1·13 | Grass, mainly brown. |
| | | Oct., 1935 | ·075 | ·31 | ·10 | ·58 | ·03 | ·24 | 5·2 | 26·0 | 2·19 | Grass, mainly green, leafy. |

AREA 2 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mayeni No. T.A.. | Entonjaneni.... | Jan., 1934 | ·10 | ·45 | ·08 | 1·06 | ·10 | ·26 | 7·6 | 45·3 | 2·56 | Grass, green. |
| | | April, 1934 | ·095 | ·11 | ·06 | ·71 | ·04 | ·28 | 5·6 | 44·5 | 1·76 | Grass, mainly green. |
| | | July, 1934 | ·04 | ·16 | ·11 | ·36 | ·03 | ·20 | 8·9 | 39·6 | 1·30 | Grass, mainly brown. |
| | | Oct., 1935 | ·14 | ·21 | ·10 | ·64 | ·13 | ·29 | 5·6 | 39·7 | 2·36 | Grass, mainly green, long. |
| | | Jan., 1935 | ·075 | ·24 | ·11 | ·64 | ·06 | ·20 | 5·5 | 38·5 | 1·79 | Grass, green, long. |
| | | Mar., 1935 | ·065 | ·44 | ·09 | ·61 | ·04 | ·18 | 4·6 | 41·3 | 1·83 | Grass, mainly green, long. |
| | | July, 1935 | ·081 | ·19 | ·11 | ·45 | ·02 | ·14 | 3·4 | 37·3 | 1·68 | Grass, mainly brown. |
| Bhonkoe No. T.A. | Entonjaneni.... | Feb., 1934 | ·079 | ·21 | ·10 | ·58 | ·06 | ·18 | 4·5 | 42·3 | 1·74 | Grass, mainly green. |
| | | May, 1934 | ·067 | ·17 | ·07 | ·43 | ·08 | ·13 | 3·9 | 42·1 | 1·58 | Grass. |
| | | Aug., 1934 | ·062 | ·24 | ·14 | ·43 | ·05 | ·13 | 4·6 | 36·9 | 1·64 | Grass, mainly brown. |
| | | Nov., 1934 | ·086 | ·20 | ·10 | ·99 | ·08 | ·25 | 7·3 | 39·4 | 2·38 | Grass, green, long. |
| | | Feb., 1935 | ·062 | ·22 | ·11 | ·66 | ·08 | ·18 | 3·9 | 40·8 | 1·79 | Grass, mainly green, long. |
| | | June, 1935 | ·056 | ·39 | ·14 | ·36 | trace | ·11 | 3·8 | 37·3 | 1·96 | Grass, mainly brown, leafy. |
| Barcow.......... | New Hanover.. | Oct., 1933 | ·10 | ·27 | ·16 | ·87 | ·14 | ·45 | 7·8 | 36·5 | 2·67 | Grass, mainly green. |
| | | Jan., 1934 | ·16 | ·23 | ·14 | 1·36 | ·15 | ·48 | 7·6 | 38·6 | 3·26 | Grass, mainly green. |
| | | April, 1934 | ·10 | ·24 | ·13 | ·94 | ·09 | ·30 | 6·8 | 38·2 | 2·47 | Grass, mainly green. |
| | | July, 1934 | ·08 | ·20 | ·11 | ·61 | ·11 | ·36 | 5·0 | 35·6 | 1·88 | Grass, leafy. |
| | | Oct., 1934 | ·13 | ·22 | ·14 | 1·04 | ·15 | ·50 | 9·0 | 35·2 | 2·80 | Grass, mainly green. leafy. |
| | | Jan., 1935 | ·12 | ·22 | ·11 | 1·34 | ·06 | ·39 | 7·4 | 37·2 | 2·78 | Grass, green. |
| | | April, 1935 | ·094 | ·21 | ·08 | ·94 | ·06 | ·32 | 5·8 | 36·4 | 2·22 | Grass, mainly green. |
| | | Oct., 1935 | ·13 | ·19 | ·13 | ·75 | ·17 | ·39 | 8·2 | 38·0 | 2·42 | Grass, green, long. |
| Sweetwaters...... | New Hanover.. | Nov., 1933 | ·17 | ·23 | ·20 | 1·46 | ·36 | ·59 | 11·4 | 34·3 | 3·87 | Grass, nainly green. |
| | | Feb., 1934 | ·098 | ·24 | ·16 | 1·14 | ·08 | ·36 | 6·5 | 39·7 | 2·68 | Grass, green. |
| | | May, 1934 | ·078 | ·19 | ·14 | 1·16 | ·07 | ·26 | 5·5 | 36·8 | 1·96 | Grass, mainly green, leafy. |
| | | Nov., 1934 | — | ·27 | ·17 | 1·02 | ·17 | — | 8·2 | 36·9 | 2·71 | Grass, mainly green. |
| | | Feb., 1935 | ·11 | ·24 | ·14 | ·90 | ·08 | ·21 | 6·2 | 34·6 | 2·59 | Grass, green, leafy. |
| | | May, 1935 | ·08 | ·25 | ·13 | ·63 | ·05 | ·09 | 5·1 | 35·7 | 2·02 | Grass, mainly green. |
| Fairview......... | New Hanover.. | Dec., 1933 | ·14 | ·22 | ·26 | 1·49 | ·18 | ·64 | 9·9 | 36·2 | 3·77 | Grass, mainly green. |
| | | Mar., 1934 | ·13 | ·20 | ·22 | 1·48 | ·26 | ·66 | 9·3 | 34·4 | 3·74 | Grass, mainly green. |
| | | June, 1934 | ·10 | ·19 | ·13 | ·75 | ·09 | ·21 | 4·2 | 37·3 | 2·09 | Grass. |
| | | Dec., 1934 | ·14 | ·21 | ·15 | 1·21 | ·19 | ·41 | 7·0 | 37·5 | 3·11 | Grass, mainly green. |
| | | Mar., 1935 | ·13 | ·21 | ·07 | ·94 | ·17 | ·29 | 6·6 | 36·5 | 2·60 | Grass, mainly green, leafy. |
| | | June, 1935 | ·068 | ·24 | ·10 | ·45 | ·02 | ·14 | 3·6 | 38·1 | 1·63 | Grass, mainly brown. |
| | | Sept., 1935 | ·19 | ·20 | ·14 | 1·31 | ·13 | ·60 | 13·0 | 34·6 | 3·63 | Grass, green, leafy. |
| Waterfall........ | New Hanover.. | Oct., 1933 | ·21 | ·31 | ·22 | 1·77 | ·48 | ·92 | 10·0 | 34·4 | 5·26 | Grass, green. |
| | | Jan., 1934 | ·18 | ·21 | ·15 | 2·06 | ·12 | ·57 | 7·8 | 40·1 | 4·40 | Grass, mainly green. |
| | | April, 1934 | ·12 | ·17 | ·17 | 1·77 | ·17 | ·32 | 10·0 | 36·3 | 3·82 | Grass, leafy. |
| | | Aug., 1934 | ·048 | ·36 | ·14 | ·35 | ·03 | ·06 | 3·1 | 40·9 | 1·41 | Grass, mainly brown. |
| | | Oct., 1934 | ·15 | ·30 | ·11 | 1·62 | ·06 | ·34 | 9·2 | 39·9 | 3·05 | Grass, green, leafy. |
| | | Jan., 1935 | ·095 | ·16 | ·12 | 1·44 | ·10 | ·48 | 4·5 | 40·2 | 2·93 | Grass, mainly green. |
| | | April, 1935 | ·13 | ·26 | ·14 | 1·05 | ·05 | ·18 | 5·4 | 37·2 | 2·58 | Grass, mainly green, leafy. |
| | | Aug., 1935 | ·11 | ·21 | ·12 | ·68 | ·06 | ·15 | 3·6 | 40·2 | 2·06 | Grass, mainly brown. |

AREA 2 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Moesrest**......... | New Hanover.. | Nov., 1933 | ·14 | ·25 | ·16 | 1·62 | ·08 | ·41 | 11·0 | 38·3 | 3·67 | Grass, green. |
| | | Feb., 1934 | ·11 | ·29 | ·19 | 1·49 | ·16 | ·40 | 6·7 | 38·3 | 3·44 | Grass, mainly green. |
| | | May, 1934 | ·094 | ·23 | ·21 | 1·00 | ·06 | ·39 | 5·5 | 38·8 | 2·48 | Grass. |
| | | Aug., 1934 | ·078 | ·26 | ·12 | ·63 | ·02 | ·13 | 6·3 | 36·1 | 2·13 | Grass, mainly brown. |
| | | Nov., 1934 | ·21 | ·44 | ·29 | 2·10 | ·18 | ·88 | 10·3 | 33·2 | 5·00 | Grass, green, leafy. |
| | | Feb., 1935 | ·093 | ·24 | ·15 | 1·22 | ·09 | ·38 | 6·2 | 37·4 | 3·40 | Grass, leafy. |
| | | May, 1935 | ·14 | ·35 | ·26 | 1·58 | ·06 | ·38 | 7·4 | 35·0 | 3·64 | Grass, mainly green, leafy. |
| | | Oct., 1935 | ·27 | ·48 | ·32 | 2·72 | ·38 | ·62 | 12·7 | 33·7 | 7·27 | Grass, green, leafy. |
| **Smidtshoek**...... | New Hanover.. | Dec., 1933 | ·13 | ·33 | ·31 | 2·16 | 21 | ·78 | 9·6 | 32·4 | 5·00 | Grass, mainly green. |
| | | Mar., 1934 | ·17 | 35 | 30 | 2·20 | ·07 | ·70 | 9·5 | 37·7 | 5·12 | Grass, mainly green. |
| | | June, 1934 | 11 | ·34 | ·26 | 1·51 | 17 | ·44 | 10·1 | 29·9 | 3·83 | Grass, mainly green, leafy. |
| | | Oct., 1934 | ·18 | ·40 | ·27 | 2·02 | 17 | ·78 | 12·3 | 34·2 | 5·14 | Grass, mainly green, leafy. |
| | | Dec., 1934 | ·22 | ·97 | ·24 | 3·51 | ·23 | 79 | 8·8 | 31·7 | 7·02 | Grass, mainly green, leafy. |
| | | Mar., 1935 | ·18 | ·81 | ·18 | 2·35 | ·12 | ·57 | 10·3 | 33·9 | 4·97 | Grass, mainly green, leafy and bush; mostly grass. |
| | | Sept., 1935 | ·12 | ·36 | ·23 | 1·55 | ·08 | ·56 | 8·5 | 33·3 | 5·22 | Grass, leafy. |
| **Kranskop No. 1**.. | Kranskop...... | Oct., 1933 | ·15 | ·16 | ·14 | 1·88 | ·21 | ·98 | 8·3 | 34·4 | 4·20 | Grass, mainly green. |
| | | Jan., 1934 | ·088 | ·14 | ·14 | ·92 | 20 | 50 | 7·3 | 37·4 | 2·46 | Grass, mainly green. |
| | | April, 1934 | ·068 | ·16 | ·12 | ·52 | ·03 | ·15 | 5·5 | 39 7 | 1·37 | Grass, mainly green, long. |
| | | July, 1934 | ·076 | ·29 | ·19 | ·35 | 07 | ·07 | 5·5 | 39·3 | 1·93 | Grass, brown. |
| | | Oct., 1934 | ·23 | ·25 | ·18 | 2·35 | ·12 | ·71 | 13·7 | 32·7 | 4·90 | Grass, green. |
| | | Jan., 1935 | ·22 | 23 | 22 | 2·19 | ·20 | ·74 | 8·6 | 40·0 | 4·54 | Grass, mainly green, long. |
| | | April, 1935 | ·17 | ·31 | ·24 | 2·04 | 24 | ·59 | 6·5 | 37·4 | 4·47 | Grass, green, long. |
| **Utunjambeli**..... | Kranskop...... | Nov., 1933 | 18 | 62 | ·32 | 2·11 | ·25 | ·94 | 16 5 | 28·4 | 6·00 | Grass, mainly green, leafy and bush. |
| | | Feb., 1934 | ·092 | ·33 | ·16 | 1·43 | ·36 | ·53 | 8·1 | 38·9 | 3·69 | Grass, green. |
| | | May, 1934 | ·042 | ·41 | ·22 | 1·04 | ·10 | ·50 | 6·4 | 39·5 | 3·10 | Grass, long and bush; mostly grass. |
| | | Aug., 1934 | ·073 | ·29 | ·15 | ·46 | ·09 | ·25 | 5·0 | 38·7 | 1·87 | Grass, mainly brown, long and bush; mostly grass. |
| | | Nov., 1934 | ·086 | ·29 | ·14 | 1·55 | ·16 | ·49 | 7·1 | 39·1 | 3·20 | Grass, mainly green, long. |
| | | Feb., 1935 | ·07 | ·23 | ·09 | ·85 | ·10 | ·17 | 6·5 | 41·0 | 2·05 | Grass, green, long. |
| | | May, 1935 | ·13 | ·41 | ·25 | 1·87 | 35 | ·50 | 9·5 | 35·2 | 4·34 | Grass, green. |
| **Doornhoek**....... | Kranskop...... | Jan., 1934 | ·15 | ·21 | ·19 | 1·98 | ·07 | ·53 | 8·3 | 37·0 | 3·82 | Grass, mainly green. |
| | | Mar., 1934 | ·13 | ·23 | ·13 | 1·05 | ·07 | ·27 | 6·8 | 39·8 | 2·46 | Grass, green, long. |
| | | June, 1934 | ·072 | ·39 | ·21 | ·62 | ·05 | ·20 | 7·9 | 36·9 | 2·68 | Grass, mainly green, long. |
| | | Sept., 1934 | ·057 | ·22 | ·06 | ·31 | ·03 | 08 | 4 8 | 38 2 | 1·39 | Grass, mainly brown. |
| | | Dec., 1934 | ·16 | ·25 | ·08 | 1·10 | ·14 | ·25 | 7·3 | 37·7 | 2·74 | Grass, mainly green, long. |
| | | Mar., 1935 | ·14 | ·25 | ·09 | 1·24 | ·08 | ·27 | 7·4 | 39·9 | 2·90 | Grass, green. |

AREA 2 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Stonehege**........ | Umvoti........ | Nov., 1933 | ·14 | ·29 | ·16 | 1·28 | ·03 | ·26 | 10·7 | 33·5 | 3·04 | Grass, mainly green, short. |
| | | Feb., 1934 | ·10 | ·26 | ·18 | 1·13 | ·03 | ·22 | 7·0 | 34·1 | 2·87 | Grass, green, short. |
| | | May, 1934 | ·06 | ·31 | ·18 | ·60 | ·01 | ·16 | 5·7 | 34·9 | 2·00 | Grass, leafy. |
| | | Aug., 1934 | ·06 | ·26 | ·10 | ·20 | ·01 | ·03 | 2·8 | 38·2 | 1·27 | Grass, brown, leafy. |
| | | Nov., 1934 | ·14 | ·33 | ·14 | 1·42 | trace | ·31 | 10·0 | 31·8 | 2·90 | Grass, green, leafy. |
| | | Feb., 1925 | ·11 | ·39 | ·15 | ·85 | ·04 | ·10 | 5·8 | 35·1 | 2·40 | Grass, green, short. |
| | | May, 1935 | ·18 | ·35 | ·19 | 1·05 | ·03 | ·24 | 7·4 | 32·4 | 2·86 | Grass, mainly green, leafy |
| **Franklin**......... | Umvoti........ | Dec., 1933 | ·088 | ·22 | ·15 | ·90 | ·02 | ·29 | 7·8 | 33·8 | 3·09 | Grass, mainly green, short. |
| | | Mar., 1934 | ·10 | ·42 | ·15 | ·82 | ·02 | ·19 | 7·3 | 33·1 | 2·70 | Grass, mainly green, short. |
| | | June, 1934 | ·05 | ·29 | ·14 | ·48 | ·01 | ·15 | 3·7 | 35·3 | 1·67 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·073 | ·28 | ·08 | ·40 | ·03 | ·10 | 3·9 | 37·8 | 1·56 | Grass, mainly brown, leafy. |
| | | Dec., 1934 | ·14 | ·44 | ·15 | ·95 | ·02 | ·20 | 8·6 | 33·8 | 2·55 | Grass, green, leafy. |
| | | Mar., 1925 | ·13 | ·41 | ·09 | 1·10 | ·02 | ·23 | 7·3 | 33·7 | 2·66 | Grass, green, short. |
| | | June, 1935 | ·077 | ·29 | ·07 | ·34 | ·01 | ·08 | 3·0 | 37·6 | 1·54 | Grass, brown, leafy. |
| **Umvoti Heights**.. | Umvoti........ | Jan., 1934 | ·15 | ·28 | ·23 | 1·12 | ·24 | ·79 | 11·5 | 30·4 | 4·70 | Grass, green, short. |
| | | July, 1934 | ·04 | ·20 | ·10 | ·23 | ·01 | ·08 | 3·2 | 34·2 | 1·26 | Grass, brown, leafy. |
| | | Oct., 1934 | ·11 | ·20 | ·14 | ·95 | ·02 | ·20 | 6·8 | 32·3 | 2·12 | Grass, green, leafy. |
| | | Jan., 1935 | ·11 | ·30 | ·16 | ·90 | ·03 | ·23 | 7·4 | 35·6 | 2·23 | Grass, mainly green, leafy. |
| | | April, 1935 | ·12 | ·25 | ·11 | ·77 | ·02 | ·12 | 6·6 | 31·1 | 1·94 | Grass, green, short. |
| **De Rust**......... | Umvoti........ | Nov., 1933 | ·14 | ·23 | ·10 | ·96 | ·05 | ·21 | 9·1 | 34·8 | 2·14 | Grass, mainly green. |
| | | Feb., 1934 | ·20 | ·27 | ·16 | 2·13 | ·06 | ·59 | 12·2 | 31·8 | 4·74 | Grass, green, short. |
| | | May, 1934 | ·063 | ·40 | ·10 | ·57 | ·03 | ·12 | 3·6 | 41·8 | 1·97 | Grass, long. |
| | | Aug., 1934 | ·027 | ·27 | ·09 | ·10 | ·01 | ·02 | 2·0 | 26·8 | 0·92 | Grass, brown, leafy. |
| | | Nov., 1934 | ·13 | ·26 | ·17 | 2·04 | ·08 | ·44 | 11·3 | 30·0 | 3·80 | Grass, green. |
| | | Feb., 1935 | ·15 | ·27 | ·12 | 1·01 | ·04 | ·17 | 6·4 | 38·5 | 2·30 | Grass, green, leafy. |
| | | May, 1935 | ·089 | ·25 | ·08 | ·72 | ·04 | ·08 | 4·4 | 40·2 | 1·82 | Grass, mainly green. |
| | | Aug., 1935 | ·046 | ·33 | ·12 | ·27 | ·06 | ·12 | 2·1 | 39·2 | 2·14 | Grass, brown, leafy. |
| **Craiglands**....... | Umvoti........ | Dec., 1933 | ·11 | ·34 | ·12 | 1·19 | ·13 | ·40 | 11·8 | 35·9 | 2·74 | Grass, green, leafy. |
| | | Mar., 1934 | ·087 | ·33 | ·14 | ·94 | ·02 | ·20 | 7·3 | 36·2 | 2·19 | Grass, green, leafy. |
| | | June, 1934 | — | ·31 | ·12 | ·64 | ·01 | — | 3·6 | 38·1 | 1·83 | Grass, mainly brown. |
| | | Sept., 1934 | ·10 | ·30 | ·08 | ·66 | ·02 | ·14 | — | 36·9 | 1·97 | Grass. |
| | | Dec., 1934 | ·094 | ·29 | ·13 | 1·12 | ·05 | ·31 | 5·2 | 37·7 | 2·43 | Grass, green, long. |
| | | Mar., 1935 | ·09 | ·43 | ·14 | 1·00 | ·02 | ·18 | 6·0 | 33·7 | 2·58 | Grass, green, leafy. |
| | | June, 1935 | ·06 | ·45 | ·13 | ·32 | trace | ·13 | 2·4 | 36·2 | 1·91 | Grass, mainly brown, leafy. |
| | | Sept., 1935 | ·056 | ·26 | ·08 | ·30 | ·03 | ·13 | 4·0 | 36·6 | 1·47 | Grass, brown. |
| **Aangelegen**....... | Umvoti........ | Jan., 1934 | ·26 | ·45 | ·41 | 3·75 | ·16 | 1·80 | 7·2 | 34·4 | 8·82 | Grass, mainly green, short. |
| | | April, 1934 | ·16 | ·51 | ·28 | 1·46 | ·20 | ·67 | 8·0 | 33·7 | 4·57 | Grass, mainly green, leafy. |
| | | July, 1934 | ·16 | ·60 | ·25 | ·63 | ·33 | ·37 | 5·4 | 37·4 | 3·38 | Grass, brown. |
| | | Oct., 1934 | ·26 | ·50 | ·33 | 3·37 | ·36 | 1·20 | 10·3 | 31·7 | 6·56 | Grass, green. |
| | | Jan., 1935 | ·20 | ·39 | ·32 | 2·67 | ·33 | 1·34 | 8·7 | 35·0 | 6·20 | Grass, green. |
| | | April, 1935 | ·12 | ·62 | ·11 | ·70 | ·02 | ·13 | 5·1 | 32·0 | 2·58 | Grass, green. |
| | | July, 1935 | ·073 | ·47 | ·13 | ·62 | ·02 | ·14 | 2·8 | 40·4 | 2·95 | Grass, brown. |
| | | Oct., 1935 | ·13 | ·46 | ·09 | ·37 | ·02 | ·07 | 3·7 | 38·8 | 2·20 | Grass, brown, long. |

AREA 2 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Killarney Water Works | Camperdown... | Feb., 1934 | ·20 | ·95 | ·44 | 2·63 | ·23 | ·52 | 15·9 | 26·0 | 8·68 | Grass, mainly green and bush; mostly bush. |
| | | May, 1934 | ·11 | ·31 | ·27 | 2·17 | ·73 | ·90 | 11·0 | 37·1 | 5·20 | Grass, mainly green. |
| | | Aug., 1934 | ·11 | ·26 | ·10 | ·43 | ·04 | ·09 | 5·9 | 37·1 | 1·68 | Grass, mainly brown. |
| | | Nov., 1934 | ·10 | ·30 | ·11 | ·98 | ·13 | ·27 | 9·7 | 41·3 | 2·43 | Grass, green. |
| | | Feb., 1935 | ·096 | ·23 | ·12 | ·97 | ·17 | ·28 | 7·1 | 37·7 | 2·30 | Grass, green. |
| | | May, 1935 | ·12 | ·19 | ·13 | ·95 | ·18 | ·32 | 6·1 | 35·1 | 2·50 | Grass, mainly green, leafy. |
| | | Aug., 1935 | ·044 | ·16 | ·05 | ·13 | ·02 | ·04 | 2·5 | 43·3 | 0·81 | Grass, brown, long. |
| Melbourne....... | Camperdown... | Dec., 1933 | ·22 | ·35 | ·23 | 2·97 | ·17 | ·70 | 14·8 | 34·1 | 6·28 | Grass, mainly green, short. |
| | | Mar., 1934 | ·19 | ·71 | ·47 | 2·00 | ·08 | ·45 | 12·5 | 33·3 | 6·07 | Grass, mainly green and bush; mostly grass. |
| | | June, 1934 | ·19 | ·58 | ·24 | 1·53 | ·20 | ·55 | 10·5 | 35·3 | 4·10 | Grass, green. |
| | | Sept., 1934 | ·17 | ·50 | ·17 | ·70 | ·08 | ·30 | 12·4 | 34·3 | 2·93 | Grass, mainly green, leafy. |
| | | Mar., 1935 | ·10 | ·28 | ·14 | ·81 | ·06 | ·20 | 6·0 | 35·7 | 1·97 | Grass, green, leafy. |
| | | June, 1935 | ·08 | ·23 | ·11 | ·59 | trace | ·11 | 4·3 | 35·6 | 1·86 | Grass, mainly brown, short. |
| | | Sept., 1935 | ·16 | ·32 | ·14 | 1·11 | ·11 | ·39 | 10·6 | 34·4 | 2·96 | Grass, mainly green, leafy. |
| Spitskop, Lot No. 18 | Camperdown... | Jan., 1934 | ·19 | ·40 | ·29 | 2·17 | ·53 | ·72 | 10·9 | 34·8 | 5·80 | Grass, green and bush; mostly grass. |
| | | April, 1934 | ·21 | ·26 | ·18 | 1·64 | ·09 | ·47 | 9·9 | 36·7 | 3·65 | Grass, mainly green. |
| | | July, 1934 | ·18 | ·57 | ·12 | 1·19 | ·10 | ·33 | 9·5 | 36·0 | 3·42 | Grass, mainly green. |
| | | Oct., 1934 | ·20 | ·37 | ·08 | 1·20 | ·16 | ·35 | 11·4 | 31·8 | 3·41 | Grass, green, leafy. |
| | | April, 1935 | ·09 | ·29 | ·13 | ·94 | ·07 | ·28 | 5·8 | 36·5 | 2·53 | Grass, green, leafy. |
| | | Aug., 1935 | ·07 | ·25 | ·11 | ·52 | ·05 | ·19 | 3·6 | 38·7 | 1·58 | Grass, mainly brown, short. |
| Marianhill........ | Pinetown...... | Nov., 1933 | ·18 | ·19 | ·11 | 1·23 | ·09 | ·28 | 10·6 | 38·9 | 2·87 | Grass, mainly green. |
| | | Feb., 1934 | ·11 | ·20 | ·15 | 1·25 | ·12 | ·33 | 7·6 | 41·6 | 2·91 | Grass, mainly green. |
| | | Aug., 1934 | ·12 | ·26 | ·14 | 1·29 | ·12 | ·23 | 6·3 | 37·7 | 2·40 | Grass. |
| | | Nov., 1934 | ·15 | ·23 | ·09 | 1·39 | ·20 | ·47 | 8·4 | 38·5 | 3·18 | Grass, leafy. |
| | | Feb., 1935 | ·17 | ·21 | ·07 | 1·33 | ·17 | ·52 | 6·3 | 41·8 | 3·17 | Grass, mainly green. |
| | | May, 1935 | ·15 | ·30 | ·08 | ·92 | ·23 | ·24 | 6·9 | 33·7 | 2·90 | Grass. |
| | | Aug., 1935 | ·097 | ·29 | ·12 | ·58 | ·10 | ·20 | 4·3 | 38·4 | 1·78 | Grass, mainly brown, leafy. |
| Glenkinnan....... | Pinetown...... | Dec., 1933 | ·19 | ·17 | ·11 | 1·33 | ·15 | ·42 | 9·4 | 33·4 | 3·06 | Grass, green. |
| | | Mar., 1934 | ·082 | ·27 | ·11 | ·87 | ·05 | ·14 | 5·6 | 35·8 | 2·06 | Grass. |
| | | June, 1934 | ·27 | ·55 | ·48 | 2·10 | ·52 | 1·32 | 12·3 | 36·1 | 6·78 | Grass, mainly green, leafy. |
| | | Sept., 1934 | ·19 | ·42 | ·29 | 1·59 | ·29 | ·88 | 8·2 | 34·0 | 4·43 | Grass, mainly green, leafy. |
| | | Dec., 1934 | ·26 | ·41 | ·32 | 1·65 | ·22 | ·66 | 7·5 | 38·3 | 4 43 | Grass, mainly green, leafy. |
| | | Mar., 1935 | 22 | 32 | ·14 | 1·90 | ·22 | ·89 | 6·7 | 40·0 | 4·55 | Grass, mainly green, leafy. |
| | | June, 1935 | ·29 | ·35 | ·34 | 1·05 | ·19 | ·51 | 7·2 | 37·5 | 4·12 | Grass, mainly green. |
| | | Sept., 1935 | 20 | ·26 | ·13 | 1·19 | ·23 | ·56 | 8·6 | 39·9 | 3·45 | Grass, green, long. |

### AREA 2 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Northdene....... | Pinetown...... | Jan., 1934 | ·078 | ·28 | ·20 | 2·69 | ·46 | ·79 | 14·1 | 34·2 | 6·11 | Grass, mainly green, leafy. |
| | | April, 1934 | ·12 | ·35 | ·23 | 1·45 | ·41 | ·78 | 9·5 | 38·2 | 4·21 | Grass. |
| | | July, 1934 | ·15 | ·43 | ·31 | 1·99 | ·44 | 1·00 | 11·6 | 32·0 | 5·42 | Grass, mainly green. |
| | | Oct., 1934 | ·12 | ·36 | ·22 | ·60 | ·47 | ·91 | 7·7 | 37·6 | 4·60 | Grass, green, long. |
| | | Jan., 1935 | ·16 | ·25 | ·18 | 2·04 | ·40 | ·73 | 10·5 | 36·7 | 4·54 | Grass, green, long. |
| | | April, 1935 | ·13 | ·27 | ·14 | ·95 | ·21 | ·55 | 6·4 | 40·0 | 2·96 | Grass, green, long. |
| | | July, 1935 | ·085 | ·30 | ·21 | ·93 | ·20 | ·46 | 7·2 | 35·8 | 3· 7 | Grass, mainly green, leafy. |
| | | Oct., 1935 | ·16 | ·35 | ·18 | 1·78 | ·24 | ·60 | 10·2 | 34·3 | 4·31 | Grass, green, long. |
| Coedmore........ | Durban........ | Nov., 1933 | ·17 | ·25 | ·20 | 1·69 | ·30 | ·69 | 11·3 | 34·4 | 4·66 | Grass, mainly green, leafy. |
| | | Feb., 1934 | ·19 | ·33 | ·19 | 2·28 | ·39 | ·96 | 8·7 | 38·7 | 6·08 | Grass, leafy. |
| | | May, 1934 | ·13 | ·24 | ·19 | 1·36 | ·35 | ·64 | 6·9 | 37·9 | 3·73 | Grass. |
| | | Aug., 1934 | ·17 | ·28 | ·18 | 1·51 | ·26 | ·47 | 9·3 | 37·6 | 3·78 | Grass, mainly green, leafy. |
| | | Nov., 1934 | ·15 | ·32 | ·14 | 1·19 | ·25 | ·62 | 8·7 | 34·9 | 3·39 | Grass, mainly green. |
| | | Feb., 1935 | ·16 | ·38 | ·17 | 1·57 | ·51 | 1·15 | 9·4 | 38·8 | 4·91 | Grass, green and bush. |
| | | May, 1935 | ·07 | ·18 | ·08 | ·69 | ·11 | ·23 | 5·1 | 39·8 | 1·90 | Grass. |
| | | Sept., 1935 | ·16 | ·46 | ·25 | 1·67 | ·33 | 1·18 | 8·5 | 35·5 | 5·16 | Grass, green, leafy. |
| Wansbeck........ | Durban........ | Mar., 1934 | ·11 | ·31 | ·22 | 1·61 | ·28 | ·72 | 5·5 | 32·5 | 4·25 | Grass. |
| | | June, 1934 | ·20 | ·57 | ·31 | 1·55 | ·39 | ·79 | 10·0 | 31·4 | 5·11 | Grass, mainly green and bush; mostly grass. |
| | | Sept., 1934 | ·14 | ·66 | ·28 | 1·65 | ·36 | ·67 | 11·3 | 33·7 | 4·73 | Grass, leafy and bush. |
| | | Jan., 1935 | ·20 | ·48 | ·26 | 2·33 | ·34 | ·87 | 10·1 | 34·3 | 5·76 | Grass, leafy and bush: mostly grass. |
| | | Mar., 1935 | ·11 | ·38 | ·11 | 1·21 | ·20 | ·46 | 8·7 | 33·8 | 3·61 | Grass, green and bush. |
| | | Aug., 1935 | ·15 | ·38 | ·32 | 1·63 | ·21 | ·67 | 9·8 | 34·3 | 4·38 | Grass, mainly green and bush: mostly grass. |
| Woodville........ | Durban........ | Jan., 1934 | ·36 | ·73 | ·50 | 3·43 | ·52 | ·69 | 16·8 | 32·4 | 9·21 | Grass and bush. |
| | | April, 1934 | ·31 | ·72 | ·47 | 2·75 | ·39 | ·80 | 16·1 | 32·5 | 7·72 | Grass and bush. |
| | | July, 1934 | ·31 | 1·04 | ·39 | 2·45 | ·30 | ·55 | 19·0 | 25·2 | 7·68 | Grass, and bush; mostly bush. |
| | | Oct., 1934 | ·22 | ·70 | ·33 | 2·22 | ·43 | ·74 | 14·8 | 31·3 | 6·70 | Grass, mainly green and bush. |
| | | Jan., 1935 | ·27 | ·57 | ·35 | 3·28 | ·27 | ·93 | 15·0 | 32·7 | 8·15 | Grass, mainly green and bush; mostly grass. |
| | | April, 1935 | ·096 | ·80 | ·35 | 2·20 | ·43 | ·75 | 13·5 | 32·3 | 6·82 | Grass, brown and bush. |
| | | July, 1935 | ·22 | ·88 | ·36 | 2·26 | ·31 | ·69 | 14·8 | 32·1 | 6·94 | Grass and bush. |
| | | Oct., 1935 | ·30 | ·45 | ·29 | 2·48 | ·26 | ·76 | 17·7 | 35·8 | 6·18 | Grass, green and bush. |
| Mount Albert.... | Lower Tugela.. | Nov., 1933 | ·13 | ·32 | ·22 | 1·47 | ·16 | ·46 | 10·0 | 36·9 | 3·86 | Grass, mainly green. |
| | | Feb., 1934 | ·068 | ·20 | ·10 | 1·05 | ·05 | ·21 | 4·8 | 41·6 | 2·17 | Grass, mainly green. |
| | | May, 1934 | ·062 | ·20 | ·12 | ·61 | ·03 | ·14 | 4·7 | 36·3 | 1·80 | Grass, mainly green. |
| | | Aug., 1934 | ·046 | ·17 | ·06 | ·43 | ·02 | ·14 | 4·4 | 42·6 | 1·25 | Grass, mainly brown. |
| | | Nov., 1934 | ·086 | ·25 | ·15 | 1·30 | ·06 | ·33 | 6·1 | 39·7 | 2·36 | Grass. |
| | | Feb., 1935 | ·067 | ·23 | ·08 | ·82 | ·06 | ·18 | 4·6 | 39·0 | 2·09 | Grass, green, long. |
| | | May, 1935 | ·068 | ·31 | ·15 | ·63 | ·05 | ·10 | 4·1 | 34·8 | 2·06 | Grass, mainly green, long. |
| | | Aug., 1935 | ·063 | ·24 | ·12 | ·54 | ·06 | ·19 | 3·6 | 37·9 | 1·82 | Grass, mainly brown, leafy. |

AREA 2 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riverside.... ... | Lower Tugela.. | Dec., 1933 | ·12 | ·18 | ·19 | 1·89 | ·36 | ·94 | 7·4 | 37·6 | 5·82 | Grass, green. |
| | | Mar., 1934 | ·089 | ·18 | ·15 | ·90 | ·15 | ·34 | 4·8 | 39·3 | 2·18 | Grass, mainly green. |
| | | June, 1934 | ·067 | ·22 | ·13 | ·70 | ·12 | ·41 | 4·6 | 39·6 | 2·16 | Grass. |
| | | Sept. 1934 | ·13 | ·19 | ·18 | ·90 | ·15 | ·39 | 6·5 | 36·5 | 2·56 | Grass, green. |
| | | Dec., 1934 | ·12 | ·19 | ·15 | 1·46 | ·20 | ·63 | 6·9 | 36·3 | 3·19 | Grass, green. |
| | | Mar., 1935 | ·074 | ·22 | ·07 | ·91 | ·08 | ·14 | 5·4 | 38·9 | 2·28 | Grass, mainly green, long. |
| | | June, 1935 | ·093 | ·28 | ·13 | ·72 | ·05 | ·41 | 4·0 | 40·1 | 2·41 | Grass. |
| | | Sept., 1935 | ·075 | ·20 | ·12 | ·83 | ·17 | ·43 | 5·7 | 35·3 | 2·62 | Grass, mainly brown, leafy. |
| Bulwer No. 1.... | Lower Tugela.. | Jan., 1934 | ·16 | ·22 | ·16 | 1·95 | ·51 | ·99 | 8·6 | 39·5 | 4·92 | Grass, mainly green. |
| | | April, 1934 | ·19 | ·26 | ·11 | 1·59 | ·19 | ·70 | 8·0 | 38·6 | 3·62 | Grass, mainly green. |
| | | July, 1934 | ·19 | ·35 | ·13 | ·81 | ·16 | ·52 | 4·9 | 37·7 | 2·86 | Grass, mainly brown. |
| | | Oct., 1934 | ·11 | ·30 | ·11 | ·77 | ·20 | ·56 | 5·3 | 33·5 | 2·73 | Grass, mainly green. |
| | | Jan., 1935 | ·10 | ·21 | ·14 | 1·49 | ·19 | ·80 | 7·0 | 35·8 | 3·37 | Grass, green. |
| | | April, 1935 | ·14 | ·35 | ·14 | 1·17 | ·20 | ·52 | 6·0 | 36·2 | 3·20 | Grass. |
| | | July,, 1935 | ·07 | ·22 | ·15 | ·58 | ·03 | ·29 | 4·9 | 37·8 | 1·96 | Grass, leafy. |
| | | Oct., 1935 | ·14 | ·19 | ·15 | 1·19 | ·18 | ·62 | 7·6 | 38·0 | 3·26 | Grass, green. |
| Lutuli No.T.A.489 | Ndwedwe...... | Nov., 1933 | ·05 | ·14 | ·08 | ·44 | ·04 | ·14 | 5·9 | 42·6 | 1·63 | Grass, short. |
| | | Feb., 1934 | ·085 | ·13 | ·07 | ·87 | ·05 | ·23 | 5·6 | 43·3 | 1·97 | Grass, long. |
| | | May, 1934 | ·094 | ·14 | ·06 | ·58 | ·03 | ·13 | 5·1 | 38·9 | 1·42 | Grass, mainly green, long. |
| | | Aug., 1934 | ·052 | ·15 | ·07 | ·33 | ·01 | ·05 | 4·9 | 40·4 | 1·23 | Grass, mainly green, long. |
| | | Nov., 1934 | ·05 | ·17 | ·05 | ·39 | trace | ·14 | 5·0 | 41·9 | 1·25 | Grass, mainly green, long. |
| | | Feb., 1935 | ·093 | ·16 | ·15 | 1·35 | ·15 | ·25 | 6·2 | 40·4 | 2·93 | Grass, green, long. |
| | | May, 1935 | ·11 | ·29 | ·19 | 1·41 | ·34 | ·54 | 7·1 | 37·4 | 3·64 | Grass, mainly green. |
| | | Aug., 1935 | ·068 | ·14 | ·05 | ·42 | ·04 | ·13 | 3·4 | 43·1 | 0·94 | Grass, long. |
| Nozandhla No. T.A. 49 | Ndwedwe...... | Dec., 1933 | ·073 | ·17 | ·07 | ·61 | ·04 | ·10 | 4·8 | 41·2 | 1·83 | Grass. |
| | | Mar., 1934 | ·044 | ·14 | ·05 | ·37 | ·05 | ·09 | 4·5 | 42·3 | 1·11 | Grass. |
| | | June, 1934 | ·035 | ·17 | ·07 | ·25 | ·03 | ·08 | 3·9 | 39·7 | 1·24 | Grass, long. |
| | | Sept., 1934 | ·051 | ·12 | ·03 | ·18 | ·03 | ·04 | 3·7 | 41·4 | 1·00 | Grass, mainly brown, long. |
| | | Dec., 1934 | ·064 | ·14 | ·05 | ·46 | ·03 | ·10 | 5·0 | 37·6 | 1·46 | Grass, green. |
| | | Mar., 1935 | ·075 | ·20 | ·06 | ·59 | ·05 | ·12 | 5·2 | 38·4 | 1·94 | Grass, mainly green. |
| | | June, 1935 | ·052 | ·18 | ·04 | ·29 | trace | ·05 | 3·7 | 42·7 | 1·16 | Grass, mainly green. |
| | | Sept., 1935 | ·04 | ·15 | ·07 | ·19 | ·04 | ·11 | 3·4 | 43·9 | 1·08 | Grass, mainly brown, long. |
| Maunduze........ | Ndwedwe...... | Jan., 1934 | ·076 | ·13 | ·08 | ·65 | ·04 | ·16 | 4·3 | 44·9 | 1·67 | Grass, mainly green, long. |
| | | April, 1934 | ·052 | ·11 | ·06 | ·43 | ·04 | ·10 | 4·5 | 43·4 | 1·24 | Grass, mainly green, long. |
| | | July, 1934 | ·06 | ·22 | ·11 | ·29 | ·03 | ·08 | 4·1 | 37·2 | 1·53 | Grass. |
| | | Oct., 1934 | ·042 | ·19 | ·07 | ·22 | ·04 | ·08 | 3·9 | 39·1 | — | Grass, mainly green, long. |
| | | Jan., 1935 | ·08 | ·13 | ·07 | ·69 | ·06 | ·10 | 5·7 | 39·6 | 1·48 | Grass, green, long. |
| | | April, 1935 | ·06 | ·13 | ·07 | ·32 | ·19 | ·11 | 4·2 | 41·7 | 1·30 | Grass, green, long. |
| | | July, 1935 | ·038 | ·21 | ·07 | ·22 | ·05 | ·10 | 3·2 | 40·6 | 2·41 | Grass, mainly brown, long. |
| | | Oct., 1935 | ·043 | ·13 | ·03 | ·18 | ·01 | ·02 | 3·8 | 40·2 | 0·78 | Grass, mainly green, long. |

### AREA 2 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rydalvale**........ | Inanda........ | Nov., 1933 | ·17 | ·32 | ·18 | 1·70 | ·23 | ·62 | 9·3 | 36·6 | 4·23 | Grass, mainly green, leafy. |
| | | Feb., 1934 | ·18 | ·21 | ·13 | 1·78 | 23 | 69 | 7 4 | 40·2 | 4·20 | Grass, mainly green. |
| | | June, 1934 | ·17 | ·28 | ·12 | 1·04 | ·09 | ·37 | 5·6 | 36·5 | 2·88 | Grass, long. |
| | | Nov., 1934 | ·19 | ·22 | ·13 | 1·67 | ·15 | 59 | 9·3 | — | 3·86 | Grass, mainly green, long. |
| | | Dec., 1934 | ·18 | ·29 | ·14 | 1·62 | ·45 | ·60 | 12 7 | 34·9 | 4·26 | Grass, mainly green. |
| | | April, 1935 | ·24 | ·28 | ·14 | 1 42 | ·14 | ·49 | 7·1 | 38·4 | 3·63 | Grass, green. |
| | | July, 1935 | ·17 | ·36 | ·29 | 1·45 | ·21 | 72 | 11·0 | 37·1 | 4·41 | Grass, green, leafy. |
| | | Sept., 1935 | ·21 | ·47 | ·18 | 1·42 | 29 | ·60 | 13·5 | 37·3 | 4·44 | Grass, green, leafy. |
| **Richmond**....... | Inanda...... .. | Dec., 1933 | ·10 | ·20 | ·13 | 1·13 | 09 | ·42 | 6·2 | 38·6 | 2·72 | Grass. |
| | | Mar., 1934 | ·12 | ·19 | ·13 | 1 21 | ·14 | ·56 | 5 2 | 39·4 | 2·82 | Grass, mainly green. |
| | | June, 1934 | ·08 | ·27 | ·15 | 1·06 | ·13 | 62 | 4·9 | 38·3 | 2·86 | Grass, long. |
| | | Nov., 1934 | ·087 | 21 | ·11 | 74 | 11 | ·30 | 4·7 | 38·5 | 2·05 | Grass, long. |
| | | Jan., 1935 | ·088 | ·18 | ·10 | 1·34 | ·14 | ·52 | 8·4 | 39·4 | 2·90 | Grass, mainly green, long. |
| | | April, 1935 | ·096 | ·25 | ·06 | 1 02 | ·09 | ·18 | 4·9 | 36·6 | 2·67 | Grass, mainly green, long. |
| | | July, 1935 | ·15 | ·38 | ·20 | ·94 | ·34 | 10 | 8 2 | 35·8 | 3·95 | Grass, mainly green, leafy. |
| **Piesang River**.... | Inanda.... ... | Jan., 1934 | ·13 | ·18 | ·14 | 1·26 | ·14 | ·40 | 5 8 | 40·7 | 2·98 | Grass, mainly green, long. |
| | | April, 1934 | ·20 | ·25 | 13 | 1 47 | ·17 | 38 | 7·9 | 37·3 | 3·40 | Grass, mainly green. |
| | | July, 1934 | ·06 | ·19 | 18 | 88 | ·18 | ·74 | 4·4 | 40·3 | 2·80 | Grass, long. |
| | | Nov., 1934 | ·076 | 17 | ·11 | ·94 | ·08 | ·39 | 4·4 | 41·3 | 1·80 | Grass, long. |
| | | Feb., 1935 | ·24 | ·19 | ·11 | ·98 | 31 | 47 | 4·7 | 40·3 | 3·64 | Grass, mainly green, long. |
| | | May, 1935 | 26 | ·27 | ·19 | ·68 | 24 | ·31 | 5·3 | 37·7 | 3·01 | Grass, long. |
| | | Aug., 1935 | ·12 | ·21 | ·16 | ·69 | 12 | ·38 | 5·0 | 38·7 | 1·92 | Grass, long. |

## AREA 3.

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Arden**.......... | Richmond..... | Dec., 1933 | ·11 | ·15 | ·10 | ·88 | ·05 | ·20 | 7·4 | 37·9 | 1·88 | Grass, green. |
| | | Mar., 1934 | ·084 | ·15 | ·09 | ·65 | ·04 | ·17 | 3·6 | 42·0 | 1·57 | Grass, green, long. |
| | | June, 1934 | ·075 | ·13 | ·12 | ·27 | ·03 | ·06 | 4·6 | 37·1 | 1·21 | Grass, long. |
| | | Sept., 1934 | ·083 | ·23 | ·09 | ·76 | ·04 | ·19 | 7·0 | 38·5 | 1·90 | Grass, green. |
| | | Dec., 1934 | ·15 | ·18 | ·09 | ·99 | ·18 | ·39 | 7·2 | 40·9 | 2·62 | Grass, green, long. |
| | | Mar., 1935 | ·17 | ·26 | ·12 | 1·37 | ·03 | ·33 | 7·4 | 38·4 | 2·99 | Grass, mainly green, leafy. |
| | | June, 1935 | ·13 | ·27 | ·09 | 1·08 | trace | ·25 | 5·2 | 39·7 | 2·41 | Grass, mainly green. |
| | | Sept., 1935 | ·17 | ·32 | ·12 | 1·29 | ·18 | ·49 | 13·5 | 36·8 | 3·23 | Grass, green, leafy. |
| **Backworth**....... | Richmond..... | Jan., 1934 | ·14 | ·16 | ·10 | 1·42 | ·08 | ·24 | 11·2 | 39·7 | 3·10 | Grass, green. |
| | | April, 1934 | ·074 | ·18 | ·10 | ·63 | ·09 | ·23 | 4·6 | 39·8 | 1·58 | Grass, mainly green, long. |
| | | July, 1934 | ·036 | ·21 | ·07 | ·27 | ·01 | ·13 | 3·8 | 39·7 | 1·15 | Grass, mainly brown, long. |
| | | Oct., 1934 | ·13 | ·24 | ·10 | ·98 | ·05 | 22 | 10·3 | 35·5 | 2·61 | Grass, green. |
| | | Jan., 1935 | ·14 | ·17 | ·06 | 1·10 | ·04 | ·21 | 5·3 | 39·7 | 2·27 | Grass, green, long. |
| | | April, 1935 | ·085 | ·25 | ·15 | ·61 | 06 | ·16 | 4·5 | 38·6 | 1·78 | Grass, mainly green. |
| | | July, 1935 | ·06 | ·16 | ·05 | ·45 | ·02 | ·11 | 4·2 | 39·9 | 1·31 | Grass, long. |
| | | Oct., 1935 | ·13 | ·18 | ·05 | ·66 | ·05 | ·28 | 9·0 | 40·5 | 2·23 | Grass, green, leafy. |
| **Ismont**.......... | Richmond..... | Nov., 1933 | ·10 | ·25 | ·13 | 1·28 | ·08 | ·34 | 9·6 | 36·5 | 2·96 | Grass, green. |
| | | Feb., 1934 | ·11 | ·18 | ·10 | 1·01 | ·04 | ·20 | 5·5 | 45·1 | 2·20 | Grass, green, long. |
| | | May, 1934 | ·064 | ·24 | ·13 | ·62 | ·04 | ·25 | 6·1 | 40·0 | 1·72 | Grass. |
| | | Aug., 1934 | ·06 | ·19 | ·09 | ·31 | ·01 | ·08 | 3·3 | 38·5 | 1·38 | Grass, mainly brown, long. |
| | | Nov., 1934 | ·13 | ·23 | ·11 | 1·48 | ·05 | ·37 | 9·1 | 40·3 | 3·10 | Grass, green, long. |
| | | Feb., 1935 | ·17 | ·29 | ·14 | 1·38 | ·09 | ·34 | 7·8 | 36·5 | 3·33 | Grass, green, long. |
| | | May, 1935 | ·083 | ·30 | ·17 | ·73 | ·07 | ·18 | 4·7 | 36·1 | 2·31 | Grass, mainly green. |
| | | Aug., 1935 | ·088 | ·25 | ·11 | ·85 | ·10 | ·43 | 4·6 | 40·4 | 2·07 | Grass, long. |
| **Glen App**........ | Richmond.... | Dec., 1933 | ·08 | ·25 | ·10 | 1·41 | ·07 | ·48 | 7·2 | 36·7 | 3·58 | Grass, mainly green. |
| | | Mar., 1934 | ·13 | ·24 | ·15 | 1·71 | ·05 | ·59 | 6·4 | 36·6 | 3·72 | Grass, mainly green. |
| | | June, 1934 | ·12 | ·37 | ·28 | 1·29 | ·09 | ·61 | 7·1 | 31·4 | 3·88 | Grass, leafy. |
| | | Aug., 1934 | ·047 | ·21 | ·11 | ·18 | ·01 | ·03 | 4·3 | 38·5 | 1·32 | Grass, brown. |
| | | Aug., 1935 | ·06 | ·22 | ·06 | ·39 | ·02 | ·04 | 4·0 | 39·0 | 1·65 | Grass, mainly brown. |
| | | Sept., 1935 | ·07 | ·25 | ·08 | ·38 | 02 | ·11 | 2·8 | 40·8 | 1·53 | Grass, mainly green. |
| **Lynmouth**....... | Richmond..... | Jan., 1934 | ·23 | ·29 | ·29 | 2·66 | ·08 | ·75 | 12·9 | 33·8 | 5·80 | Grass, mainly green. |
| | | April, 1934 | ·15 | ·22 | ·16 | 1·53 | 08 | ·47 | 6·2 | 37·0 | 3·38 | Grass, mainly green. |
| | | Aug., 1934 | ·054 | ·18 | ·09 | ·27 | ·03 | ·06 | 3·9 | 43·8 | 1·16 | Grass, mainly brown long. |
| | | Oct., 1934 | ·11 | ·25 | ·10 | ·46 | ·15 | ·18 | 6·6 | 40·2 | 2·05 | Grass, mainly green, long. |
| | | Aug., 1935 | ·12 | ·25 | ·13 | ·86 | ·09 | ·20 | 6·4 | 37·4 | 2·32 | Grass, mainly brown. |
| **The Hill**......... | Richmond..... | Feb., 1934 | ·092 | ·24 | ·18 | ·91 | ·13 | ·48 | 7·6 | 39·2 | 2·41 | Grass, green, long. |
| | | May, 1934 | ·075 | ·19 | ·14 | ·68 | ·15 | ·42 | 5·3 | 38·6 | 2·27 | Grass. |
| | | Sept., 1934 | ·11 | ·24 | ·14 | 1·18 | ·17 | ·50 | 13·9 | 33·3 | 2·94 | Grass, mainly green. |
| | | May, 1935 | ·076 | ·24 | ·09 | ·68 | ·08 | ·18 | 6·9 | 36·5 | 1·73 | Grass, mainly green. |

## AREA 3 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Woolwash........ | Pietermaritzburg | Jan., 1934 | ·13 | ·21 | ·14 | 1·72 | ·12 | ·32 | 7·8 | 38·1 | 4·05 | Grass, mainly green. |
| | | April, 1934 | ·11 | ·21 | ·10 | 1·06 | ·04 | ·18 | 5·8 | 40·2 | 2·18 | Grass, long. |
| | | Nov., 1934 | ·11 | ·26 | ·14 | ·86 | ·07 | ·28 | 9·1 | 39·4 | 2·28 | Grass, green, long |
| | | Feb., 1935 | ·11 | ·31 | ·11 | ·93 | ·12 | ·20 | 6·3 | 39·8 | 2·29 | Grass, green, long. |
| | | May, 1935 | ·10 | ·26 | ·12 | 1·04 | ·04 | ·18 | 4·8 | 37·2 | 2·41 | Grass, long. |
| | | Aug., 1935 | ·084 | ·41 | ·09 | ·29 | ·05 | ·16 | 2·4 | 40·9 | 1·67 | Grass, mainly brown, leafy. |
| | | Sept., 1935 | ·063 | ·25 | ·04 | ·33 | ·03 | ·11 | 3·9 | 39·4 | 1·45 | Grass. |
| Kingston........ | Pietermaritzburg | Feb., 1934 | ·20 | ·23 | ·13 | 1·41 | ·07 | ·44 | 6·9 | 42·7 | 3·43 | Grass, mainly green. |
| | | June, 1934 | ·12 | ·30 | ·19 | ·77 | ·15 | ·47 | 3·5 | 37·8 | 3·88 | Grass, long. |
| | | Dec., 1934 | ·15 | ·22 | ·16 | 1·75 | ·14 | ·53 | 7·7 | 37·4 | 3·63 | Grass, mainly green, long. |
| | | Mar., 1935 | ·16 | ·24 | ·12 | 1·12 | ·06 | ·30 | 5·1 | 38·6 | 2·88 | Grass, green, long. |
| Belfast.......... | Pietermaritzburg | Mar., 1934 | ·094 | ·24 | ·16 | 1·12 | ·03 | ·25 | 5·6 | 38·6 | 2·46 | Grass, mainly green. |
| | | June, 1934 | ·055 | ·25 | ·15 | ·59 | ·07 | ·25 | 3·7 | 38·3 | 2·10 | Grass, mainly brown. |
| | | Jan., 1935 | ·11 | ·27 | ·20 | ·93 | ·05 | ·22 | 6·3 | 39·1 | 2·28 | Grass, green, long. |
| | | April, 1935 | ·09 | ·29 | ·15 | ·78 | ·15 | ·18 | 5·0 | 36·2 | 2·18 | Grass, mainly green, long. |
| | | July, 1935 | ·098 | ·25 | ·08 | ·42 | ·03 | ·15 | 3·3 | 40·8 | 1·77 | Grass, mainly brown. |
| | | Oct., 1935 | ·062 | ·22 | ·06 | ·19 | ·02 | ·03 | 3·2 | 39·9 | 1·00 | Grass, brown, long. |
| Roseneath....... | Ixopo.......... | Nov., 1933 | ·08 | ·23 | ·14 | ·80 | ·03 | ·21 | 5·2 | 36·7 | 2·15 | Grass. |
| | | Feb., 1934 | ·14 | ·26 | ·17 | 1·50 | ·08 | ·44 | 5·7 | 37·9 | 3·05 | Grass, mainly green. |
| | | May, 1934 | ·07 | ·20 | ·17 | 1·07 | ·02 | ·41 | 4·4 | 35·9 | 2·69 | Grass, leafy. |
| | | Aug., 1934 | ·05 | ·28 | ·08 | ·25 | ·01 | ·07 | 3·4 | 37·2 | 1·44 | Grass, mainly brown, leafy. |
| | | Nov., 1934 | ·13 | ·22 | ·20 | 1·35 | ·09 | ·70 | 8·8 | 35·2 | 3·77 | Grass, green, leafy. |
| | | Feb., 1935 | ·18 | ·22 | ·11 | 2·00 | ·13 | ·38 | 8·1 | 37·4 | 4·01 | Grass, green, leafy. |
| | | May, 1935 | ·07 | ·30 | ·10 | ·42 | ·04 | ·07 | 3·6 | 34·4 | 1·71 | Grass. |
| | | Aug., 1935 | ·053 | ·30 | ·15 | ·21 | ·03 | ·09 | 2·6 | 34·9 | 1·67 | Grass, mainly brown, leafy. |
| Chatwell......... | Ixopo.......... | Dec., 1933 | ·072 | ·18 | ·09 | ·89 | ·05 | ·36 | 7·0 | 37·4 | 2·27 | Grass, mainly green. |
| | | Mar., 1934 | ·08 | ·17 | ·12 | ·66 | ·02 | ·19 | 6·3 | 37·3 | 2·28 | Grass, short. |
| | | June, 1934 | ·033 | ·24 | ·16 | — | ·01 | ·07 | 3·0 | 35·8 | 1·63 | Grass, short. |
| | | Sept., 1934 | ·06 | ·23 | ·08 | ·28 | ·13 | ·14 | 3·8 | 39·9 | 1·09 | Grass, mainly brown. |
| | | Dec., 1934 | ·13 | ·19 | ·06 | 1·48 | ·08 | ·35 | 10·8 | 36·1 | 3·05 | Grass, green. |
| | | Mar., 1935 | ·17 | ·24 | ·12 | ·97 | ·02 | ·21 | 4·1 | 35·7 | 2·91 | Grass, mainly green, leafy. |
| | | June, 1935 | ·053 | ·20 | ·12 | ·25 | trace | ·06 | 3·6 | 36·9 | 1·64 | Grass, brown. |
| | | Sept., 1935 | ·058 | ·22 | ·11 | ·33 | ·01 | ·11 | 3·7 | 37·4 | 3·40 | Grass, mainly brown, leafy. |
| Rosedene........ | Ixopo.......... | Jan., 1934 | ·11 | ·27 | ·16 | 1·57 | ·03 | ·45 | 5·4 | 39·7 | 3·70 | Grass, mainly green, short. |
| | | April, 1934 | ·052 | ·18 | ·12 | ·57 | ·03 | ·12 | 4·3 | 38·0 | 1·53 | Grass, mainly brown, short. |
| | | July, 1934 | ·04 | ·24 | ·17 | ·34 | ·01 | ·18 | 3·1 | 37·4 | 1·80 | Grass, brown, short. |
| | | Oct., 1934 | ·064 | ·34 | ·14 | ·41 | ·03 | ·17 | 3·9 | 36·8 | 1·71 | Grass, leafy. |
| | | Jan., 1935 | ·092 | ·25 | ·15 | 1·42 | ·05 | ·37 | 6·4 | 35·9 | 2·86 | Grass, green, leafy. |
| | | April, 1935 | ·07 | ·34 | ·16 | ·64 | ·02 | ·12 | 5·2 | 34·0 | 2·36 | Grass, mainly green, leafy. |
| | | July, 1935 | ·076 | ·26 | ·16 | ·32 | ·03 | ·12 | 2·7 | 37·9 | 1·47 | Grass, mainly brown, leafy. |
| | | Oct., 1935 | ·07 | ·23 | ·13 | ·57 | ·03 | ·10 | 5·1 | 36·6 | 1·84 | Grass, mainly brown, leafy. |

AREA 3 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conference....... | Ixopo......... | Nov., 1933 | ·22 | ·30 | ·25 | 1·99 | ·06 | ·58 | 14·0 | 30·8 | 4·60 | Grass, mainly green, leafy. |
| | | Feb., 1934 | ·085 | ·32 | ·15 | ·96 | ·07 | ·24 | 5·0 | 33·5 | 2·28 | Grass, green, short. |
| | | May, 1934 | ·094 | — | ·19 | ·64 | trace | ·21 | 4·2 | 31·5 | 2·73 | Grass, mainly green, leafy. |
| | | Nov., 1934 | ·11 | ·24 | ·09 | 1·12 | ·03 | ·24 | 6·4 | 33·6 | 2·40 | Grass, mainly green, leafy. |
| | | Feb., 1935 | ·11 | ·53 | ·17 | 1·22 | ·03 | ·32 | 6·5 | 33·8 | 3·15 | Grass, green, leafy and bush; mostly grass. |
| | | May, 1935 | ·12 | ·36 | ·07 | ·43 | trace | ·16 | 3·5 | 30·9 | 1·71 | Grass, leafy. |
| Saltsprings....... | Ixopo......... | Dec., 1933 | ·14 | ·31 | ·17 | 2·04 | ·05 | ·40 | 8·9 | 36·5 | 4·12 | Grass, mainly green. |
| | | Mar., 1934 | ·09 | ·31 | ·15 | ·81 | ·02 | ·20 | 5·7 | 27·9 | 2·19 | Grass, mainly green. |
| | | June, 1934 | ·063 | ·29 | ·10 | ·31 | ·01 | ·11 | 3·3 | 33·1 | 1·46 | Grass, mainly brown, leafy. |
| | | Dec., 1934 | — | ·33 | ·16 | 1·42 | ·04 | — | 9·0 | 34·6 | 3·08 | Grass, green, leafy. |
| | | Mar., 1935 | ·10 | ·42 | ·14 | ·68 | trace | ·15 | 4·9 | 30·5 | 2·07 | Grass, green, leafy. |
| | | Sept., 1935 | ·096 | ·24 | ·10 | ·62 | ·03 | ·21 | 6·2 | 33·1 | 1·84 | Grass, mainly green, leafy. |
| Sunnyside........ | Ixopo......... | Jan., 1934 | ·13 | ·27 | ·15 | 1·39 | ·02 | ·31 | 7·2 | 36·7 | 2·94 | Grass, mainly green, short. |
| | | April, 1934 | ·12 | ·38 | ·17 | 1·30 | ·03 | ·42 | 6·3 | 37·4 | 3·35 | Grass, mainly green. |
| | | Oct., 1934 | ·072 | ·23 | ·09 | ·54 | ·02 | ·12 | 4·5 | 33·1 | 1·68 | Grass, leafy. |
| | | Jan., 1935 | ·10 | ·36 | ·15 | 1·36 | ·03 | ·28 | 6·6 | 32·9 | 2·84 | Grass, green, leafy. |
| | | April, 1935 | ·09 | ·33 | ·12 | ·70 | ·03 | ·10 | 4·4 | 32·9 | 1·88 | Grass, green, leafy. |
| Finchley......... | Ixopo......... | Nov., 1933 | ·16 | ·26 | ·14 | 1·62 | ·14 | ·44 | 11·8 | 38·5 | 3·92 | Grass, green, short. |
| | | Feb., 1934 | ·088 | ·20 | ·10 | 1·21 | ·10 | ·38 | 6·3 | 39·7 | 2·83 | Grass, mainly green, short. |
| | | June, 1934 | ·057 | ·23 | ·16 | ·27 | ·05 | ·19 | 3·6 | 38·6 | 1·56 | Grass, leafy. |
| | | Sept., 1934 | — | ·21 | ·08 | ·44 | ·17 | — | 6·1 | 36·2 | 1·74 | Grass, short. |
| | | Dec., 1934 | ·096 | ·22 | ·08 | ·98 | ·03 | ·31 | 7·6 | 34·6 | 2·39 | Grass, green ,leafy. |
| | | Mar., 1935 | ·086 | ·22 | ·16 | ·59 | ·03 | ·13 | 6·3 | 34·4 | 2·57 | Grass, mainly green, short. |
| | | July, 1935 | ·077 | ·30 | ·27 | ·28 | ·04 | ·15 | 4·5 | 40·1 | 2·17 | Grass, mainly brown, short. |
| | | Sept., 1935 | ·085 | ·24 | ·07 | ·69 | ·08 | ·29 | 7·1 | 33·2 | 2·71 | Grass, mainly green, short. |
| Cromleigh........ | Ixopo......... | Jan., 1934 | ·10 | ·22 | ·13 | ·52 | ·07 | ·28 | 7·7 | 35·9 | 2·27 | Grass, green, short. |
| | | April, 1934 | ·07 | ·22 | ·14 | ·51 | ·03 | ·18 | 8·3 | 38·4 | 1·68 | Grass, mainly green, leafy. |
| | | July, 1934 | ·043 | ·25 | ·14 | ·18 | ·01 | ·05 | 2·7 | 37·0 | 1·36 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·06 | ·20 | ·19 | ·65 | ·07 | ·17 | 6·4 | 36·2 | 2·06 | Grass, mainly green, short. |
| | | Mar., 1935 | ·083 | ·29 | ·16 | ·89 | ·01 | ·19 | 5·3 | 36·2 | 2·43 | Grass, green. |
| Olivar........... | Ixopo......... | Jan., 1934 | ·15 | ·19 | ·15 | 1·27 | ·15 | ·38 | 7·3 | 37·9 | 3·13 | Grass, mainly green, short. |
| | | May, 1934 | ·06 | ·22 | ·13 | ·63 | ·04 | ·23 | 4·9 | 35·8 | 1·78 | Grass, mainly brown, leafy. |
| | | Aug., 1934 | ·047 | ·22 | ·13 | ·21 | ·01 | ·03 | 2·6 | 38·9 | 1·31 | Grass, brown, leafy. |
| | | Nov., 1934 | ·15 | ·30 | ·16 | 1·18 | ·07 | ·40 | 10·8 | 32·0 | 3·52 | Grass, green, short. |
| | | Feb., 1935 | ·066 | ·20 | ·16 | ·71 | ·03 | ·16 | 3·9 | 35·3 | 1·59 | Grass, green, leafy. |
| | | May, 1935 | ·088 | ·35 | ·15 | ·87 | ·07 | ·29 | 4·9 | 30·7 | 3·08 | Grass, mainly green, short. |
| | | Aug., 1935 | ·067 | ·35 | ·13 | ·36 | ·03 | ·12 | 3·7 | 35·1 | 2·28 | Grass, brown, short. |
| | | Oct., 1935 | ·09 | ·42 | ·16 | ·58 | ·18 | ·19 | 6·4 | 31·1 | 3·86 | Grass, short. |

## AREA 3 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Colbeck.......... | Polela......... | Nov., 1933 | ·17 | ·66 | ·18 | 1·59 | ·02 | ·24 | 12·1 | 31·0 | 4·90 | Grass, short and bush; mostly grass. |
| | | Feb., 1934 | ·093 | ·19 | ·10 | 1·17 | ·01 | ·24 | 5·4 | 41·6 | 2·25 | Grass, mainly green, leafy. |
| | | April, 1935 | ·07 | ·29 | ·15 | ·59 | ·03 | ·14 | 5·8 | 36·0 | 3·16 | Grass, green, leafy. |
| | | July, 1935 | ·048 | ·28 | ·10 | ·28 | ·01 | ·09 | 2·3 | 41·7 | 1·32 | Grass, brown, leafy. |
| Sterling.......... | Polela......... | Dec., 1933 | ·14 | ·28 | ·12 | 1·46 | ·02 | ·34 | 8·0 | 37·7 | 3·08 | Grass, mainly green, leafy. |
| | | Mar., 1934 | ·12 | ·23 | ·10 | 1·24 | ·02 | ·25 | 7·6 | 37·9 | 3·91 | Grass, mainly green, short. |
| | | May, 1935 | ·10 | ·50 | ·11 | ·68 | trace | ·12 | 3·8 | 30·4 | 1·77 | Grass, leafy. |
| | | Aug., 1935 | ·06 | ·31 | ·09 | ·23 | ·02 | ·09 | 3·3 | 34·5 | 1·72 | Grass, brown, leafy. |
| Grassmere....... | Polela......... | Jan., 1934 | ·10 | ·27 | ·14 | 1·19 | ·03 | ·24 | 6·3 | 35·1 | 2·56 | Grass, mainly green, short. |
| | | April, 1934 | ·09 | ·24 | ·12 | ·96 | ·03 | ·21 | 6·4 | 32·3 | 2·36 | Grass, mainly green, short. |
| | | June, 1935 | ·03 | ·29 | ·09 | ·19 | trace | ·07 | 2·9 | 35·2 | 1·42 | Grass, mainly brown, leafy. |
| | | Sept., 1935 | ·077 | ·22 | ·07 | ·37 | ·02 | ·11 | 4·3 | 37·9 | 1·50 | Grass, mainly brown, leafy. |
| Briarlea......... | Polela......... | Nov., 1933 | ·18 | ·28 | ·18 | 1·80 | ·04 | ·35 | 12·6 | 33·6 | 3·64 | Grass, green, leafy. |
| | | Feb., 1934 | ·09 | ·22 | ·14 | 1·09 | ·01 | ·21 | 7·2 | 36·8 | 2·70 | Grass, green, short. |
| | | May, 1934 | ·065 | ·21 | ·08 | ·86 | ·01 | ·18 | 5·6 | 32·6 | 1·91 | Grass, mainly green, leafy. |
| | | Aug., 1934 | ·025 | ·19 | ·09 | ·19 | trace | ·07 | 2·9 | 35·0 | 1·03 | Grass, mainly brown, leafy. |
| | | Nov., 1934 | ·13 | ·29 | ·14 | 1·21 | ·06 | ·28 | 9·1 | 32·4 | 2·70 | Grass, green, short. |
| | | Feb., 1935 | ·092 | ·26 | ·14 | 1·02 | trace | ·16 | 6·4 | 32·7 | 1·96 | Grass, green, short. |
| | | May, 1935 | ·07 | ·31 | ·14 | ·73 | ·02 | ·10 | 5·8 | 32·3 | 2·05 | Grass, mainly green, leafy. |
| | | Aug., 1935 | ·08 | ·39 | ·15 | ·59 | ·03 | ·08 | 4·5 | 37·7 | 2·25 | Grass, brown, leafy. |
| Kildare.......... | Polela......... | Feb., 1934 | ·11 | ·24 | ·11 | 1·58 | ·02 | ·20 | 8·0 | 36·9 | 2·42 | Grass, mainly green, short. |
| | | Mar., 1934 | ·08 | ·23 | ·18 | ·99 | ·02 | ·29 | 6·1 | 37·8 | 2·41 | Grass, mainly green, leafy. |
| | | June, 1934 | ·10 | ·21 | ·12 | 1·23 | ·01 | ·33 | 6·1 | 30·7 | 3·25 | Grass, leafy. |
| | | Sept., 1934 | ·10 | ·15 | ·12 | 1·02 | ·01 | ·29 | 10·0 | 33·8 | 2·19 | Grass, green, leafy. |
| | | Dec., 1934 | ·14 | ·32 | ·08 | 1·27 | ·18 | ·30 | 10·0 | 31·0 | 3·01 | Grass, green, short. |
| | | Mar., 1935 | ·093 | ·23 | ·10 | ·55 | trace | ·17 | 6·8 | 32·2 | 2·11 | Grass, green, short. |
| | | July, 1935 | ·19 | ·54 | ·17 | ·95 | ·21 | ·49 | 6·7 | 30·5 | 3·55 | Grass, leafy (Yorkshire Fog). |
| | | Sept., 1935 | ·11 | ·18 | ·14 | 1·41 | ·04 | ·49 | 8·7 | 33·9 | 3·59 | Grass, mainly green, leafy. |
| Snowhill......... | Polela......... | Jan., 1934 | ·14 | ·28 | ·11 | 1·32 | ·02 | ·24 | 8·2 | 35·0 | 2·72 | Grass, green, short. |
| | | April, 1934 | ·076 | ·26 | ·13 | ·86 | ·02 | ·14 | 5·8 | 37·7 | 1·87 | Grass, mainly green, leafy. |
| | | July, 1934 | ·046 | ·31 | ·23 | ·38 | trace | ·14 | 3·9 | 34·8 | 1·72 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·13 | ·20 | ·14 | 1·15 | ·04 | ·23 | 9·6 | 32·0 | 2·53 | Grass, green, short. |
| | | July, 1935 | ·064 | ·29 | ·12 | ·37 | ·03 | ·06 | 3·6 | 38·7 | 1·52 | Grass, mainly brown, leafy. |
| | | Oct., 1935 | ·16 | ·32 | ·15 | 1·72 | ·05 | ·37 | 11·5 | 35·0 | 3·64 | Grass, green, short. |
| White Rocks..... | Impendhle..... | Nov., 1933 | ·15 | ·23 | ·12 | 1·73 | ·03 | ·51 | 11·3 | 36·6 | 3·68 | Grass, mainly green, short. |
| | | Feb., 1934 | ·16 | ·16 | ·15 | 2·05 | ·02 | ·23 | 9·3 | 33·6 | 4·00 | Grass, green. |
| | | June, 1934 | ·082 | ·27 | ·06 | ·70 | ·02 | ·12 | 4·2 | 36·7 | 1·93 | Grass, mainly brown. |
| | | Aug., 1934 | ·05 | ·21 | ·09 | ·26 | trace | ·02 | 3·1 | 34·9 | 1·27 | Grass, mainly brown, leafy. |
| | | May, 1935 | ·085 | ·18 | ·09 | ·78 | ·02 | ·33 | 4·5 | 35·9 | 1·93 | Grass, mainly green, short. |
| | | Aug., 1935 | ·057 | ·31 | ·10 | ·28 | ·04 | ·07 | 3·7 | 34·7 | 1·60 | Grass, brown, short. |

AREA 3 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Brooklyn**........ | **Impendhle**..... | Dec., 1933 | ·14 | ·30 | ·18 | 1·63 | ·03 | ·38 | 8·3 | 35·2 | 3·22 | Grass, green. |
| | | Mar., 1934 | ·11 | ·32 | ·13 | 1·30 | ·02 | ·26 | 7·3 | 37·6 | 2·55 | Grass, mainly green. |
| | | June, 1934 | ·13 | ·36 | ·17 | 1·74 | ·15 | ·48 | 9·7 | 36·4 | 3·64 | Grass, leafy. |
| | | Sept., 1934 | ·19 | ·38 | ·25 | 1·96 | ·03 | ·52 | 15·5 | 30·3 | 4·30 | Grass, green, leafy. |
| | | June, 1935 | ·053 | ·26 | ·10 | ·38 | trace | ·09 | 2·9 | 37·6 | 2·01 | Grass, brown, short. |
| | | Sept., 1935 | ·068 | ·37 | ·06 | ·35 | ·06 | ·14 | 3·7 | 35·4 | 2·09 | Grass, brown, short. |
| **Inhluzani**........ | **Impendhle**..... | Jan., 1934 | ·14 | ·26 | ·15 | 1·28 | ·02 | ·28 | 8·8 | 39·5 | 2·87 | Grass, mainly green, leafy. |
| | | April, 1934 | ·087 | ·32 | ·12 | ·83 | ·03 | ·16 | 5·4 | 34·6 | 2·11 | Grass, mainly green, leafy. |
| | | July, 1934 | ·05 | ·29 | ·12 | ·27 | ·01 | ·14 | 2·8 | 34·8 | 1·38 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·25 | ·31 | ·14 | 1·52 | ·08 | ·37 | 13·5 | 27·8 | 3·40 | Grass, green, leafy. |
| | | April, 1935 | ·084 | ·23 | ·12 | ·70 | ·07 | ·18 | 5·1 | 31·5 | 2·34 | Grass, mainly brown, short. |
| | | July, 1935 | ·062 | ·33 | ·16 | ·36 | ·18 | ·19 | 4·4 | 32·8 | 2·26 | Grass, brown, short. |
| | | Oct., 1935 | ·10 | ·20 | ·07 | ·86 | ·02 | ·18 | 6·5 | 35·7 | 2·26 | Grass, mainly green, short. |
| **Edgerton**........ | **Umzimkulu**.... | Nov., 1933 | ·07 | ·22 | ·13 | ·54 | ·01 | ·15 | 4·7 | 33·9 | 2·27 | Grass, mainly brown. |
| | | Mar., 1934 | ·12 | ·33 | ·16 | ·99 | ·02 | ·18 | 5·8 | 35·9 | 2·54 | Grass, mainly green, short. |
| | | July, 1934 | ·066 | ·31 | ·11 | ·51 | trace | ·16 | 3·1 | 33·5 | 1·78 | Grass, mainly brown, leafy. |
| | | June, 1935 | ·056 | ·28 | ·10 | ·51 | ·01 | ·14 | 3·2 | 39·7 | 1·75 | Grass, mainly brown. |
| | | Sept., 1935 | ·053 | ·18 | ·04 | ·25 | ·04 | ·07 | 2·8 | 38·9 | 1·29 | Grass, brown. |
| **Middleton**........ | **Umzimkulu**.... | Dec., 1933 | ·13 | ·23 | ·16 | 1·30 | ·04 | ·37 | 8·7 | 35·9 | 2·82 | Grass, mainly green, short. |
| | | April, 1934 | ·074 | ·26 | ·15 | ·78 | ·02 | ·18 | 6·5 | 35·4 | 2·13 | Grass, mainly green, short. |
| | | Aug., 1934 | ·05 | ·22 | ·10 | ·17 | trace | ·03 | 3·2 | 35·1 | 1·21 | Grass, mainly brown, leafy. |
| | | Feb., 1935 | ·12 | ·39 | ·27 | 2·04 | ·08 | ·28 | 8·1 | 34·8 | 4·32 | Grass, mainly green, leafy and bush: mostly grass. |
| | | Mar., 1935 | ·087 | ·20 | ·09 | 1·12 | ·04 | ·24 | 7·2 | 36·7 | 2·51 | Grass, mainly green, leafy. |
| | | May, 1935 | ·11 | ·31 | ·13 | ·81 | ·04 | ·20 | 4·5 | 36·1 | 2·13 | Grass, |
| | | Aug., 1935 | ·084 | ·25 | ·08 | ·27 | trace | ·09 | 3·3 | 42·8 | 1·22 | Grass, brown. |
| **Pata's Location**.. | **Umzimkulu**.... | Jan., 1935 | ·20 | ·41 | ·21 | 2·56 | ·38 | 1·10 | 9·8 | 34·5 | 5·10 | Grass, green, leafy. |
| | | April, 1935 | ·17 | ·29 | ·12 | 1·29 | ·17 | ·18 | 4·9 | 36·6 | 2·98 | Grass, mainly green. |
| | | July, 1935 | ·10 | ·32 | ·15 | ·52 | ·03 | ·09 | 4·9 | 37·4 | 1·98 | Grass, brown, leafy. |
| **Rasmeni's Location** | **Umzimkulu**.... | Nov., 1933 | ·12 | ·18 | ·12 | 1·04 | ·02 | ·29 | 8·8 | 36·7 | 3·24 | Grass, green. |
| | | Feb., 1934 | ·08 | ·29 | ·13 | ·85 | ·04 | ·16 | 5·9 | 41·7 | 1·92 | Grass, green. |
| | | May, 1934 | ·062 | ·38 | ·15 | ·54 | ·02 | ·17 | 4·1 | 35·8 | 1·87 | Grass, leafy. |
| | | Aug., 1934 | ·038 | ·36 | ·14 | ·18 | trace | ·02 | 2·6 | 40·1 | 1·41 | Grass, brown. |
| | | Nov., 1934 | ·078 | ·30 | ·11 | ·81 | trace | ·16 | 5·1 | 38·1 | 1·97 | Grass, mainly green, leafy. |
| | | Feb., 1935 | ·06 | ·42 | ·19 | ·38 | trace | ·07 | 4·3 | 35·7 | 1·93 | Grass, green, long. |
| | | May, 1935 | ·074 | ·41 | ·15 | ·34 | ·02 | ·08 | 3·5 | 35·2 | 1·93 | Grass, long. |
| | | Aug., 1935 | ·074 | ·42 | ·11 | ·20 | trace | ·07 | 2·0 | 32·2 | 1·45 | Grass, brown, leafy. |

## AREA 3 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mvubukazi Location No. 10 | Umzimkulu.... | Dec., 1933 | ·12 | ·22 | ·10 | 1·19 | ·08 | ·25 | 8·0 | 36·0 | 2·68 | Grass, mainly green, short. |
| | | Mar., 1934 | ·096 | ·24 | ·13 | ·93 | ·07 | ·24 | 6·8 | 39·8 | 2·38 | Grass, mainly green. |
| | | June, 1934 | ·052 | ·22 | ·06 | ·41 | ·03 | ·14 | 4·1 | 36·6 | 1·63 | Grass, mainly brown. |
| | | Sept., 1934 | ·048 | ·25 | ·07 | ·48 | ·03 | ·06 | 4·8 | 37·8 | 1·51 | Grass, mainly brown. |
| | | Dec., 1934 | ·09 | ·22 | ·05 | ·95 | ·04 | ·19 | 8·5 | 34·8 | 2·34 | Grass, green, leafy. |
| | | Mar., 1935 | ·07 | ·15 | ·05 | ·46 | ·01 | ·09 | 6·5 | 38·9 | 1·44 | Grass, mainly green. |
| | | June, 1935 | ·088 | ·22 | ·07 | ·35 | trace | ·20 | 4·4 | 40·3 | 1·70 | Grass, mainly brown. |
| | | Sept., 1935 | ·053 | ·21 | ·05 | ·25 | ·03 | ·10 | 4·8 | 38·5 | 1·57 | Grass, brown, leafy. |
| Kippendavie..... | Umzimkulu.... | Jan., 1934 | ·13 | ·28 | ·17 | 1·10 | ·07 | ·29 | 9·8 | 37·8 | 2·94 | Grass, mainly green. |
| | | May, 1934 | ·14 | ·29 | ·20 | ·75 | ·04 | ·24 | 4·2 | 38·3 | 2·32 | Grass, leafy. |
| | | July, 1934 | ·043 | ·25 | ·14 | ·16 | ·01 | ·03 | 2·6 | 36·4 | 1·28 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·12 | ·32 | ·18 | ·76 | ·05 | ·42 | 6·5 | 36·9 | 2·38 | Grass, mainly green, leafy. |
| | | Jan., 1935 | ·096 | ·26 | ·19 | 1·27 | ·09 | ·71 | 6·6 | 36·6 | 2·68 | Grass, green, leafy. |
| | | April, 1935 | ·14 | ·24 | ·16 | 1·01 | ·06 | ·28 | 5·3 | 36·3 | 2·31 | Grass, mainly green. |
| | | July, 1935 | ·072 | ·37 | ·15 | ·40 | ·06 | ·26 | 2·5 | 38·3 | 1·93 | Grass, mainly brown, leafy. |
| | | Nov., 1935 | ·16 | ·40 | ·18 | 1·34 | ·07 | ·32 | 11·4 | 33·9 | 3·59 | Grass, green, leafy. |
| Tshanibezwe's Location | Umzimkulu.... | Nov., 1933 | ·17 | ·32 | ·14 | 1·46 | ·01 | ·30 | 13·5 | 31·8 | 3·27 | Grass, green, short. |
| | | Feb., 1934 | ·08 | ·28 | ·15 | 1·14 | ·03 | ·23 | 6·0 | 35·6 | 2·35 | Grass, green, leafy. |
| | | May, 1934 | ·043 | ·27 | ·14 | ·43 | ·02 | ·12 | 3·9 | 35·4 | 1·69 | Grass, short. |
| | | Aug., 1934 | ·043 | ·27 | ·12 | ·20 | ·01 | ·04 | 3·9 | 35·8 | 1·33 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·087 | ·24 | ·13 | ·60 | ·02 | ·20 | 5·4 | 32·4 | 1·83 | Grass, leafy. |
| | | Feb., 1935 | ·13 | ·31 | ·19 | ·93 | ·03 | ·20 | 9·6 | 31·4 | 2·56 | Grass, green, short. |
| | | May, 1935 | ·084 | ·23 | ·13 | ·88 | ·02 | ·16 | 5·9 | 38·2 | 1·84 | Grass, mainly green, short. |
| Oxton........... | Umzimkulu.... | Dec., 1933 | ·16 | ·65 | ·24 | 2·11 | ·06 | ·72 | 11·4 | 30·7 | 6·42 | Grass, mainly green, and bush. |
| | | Mar., 1934 | ·10 | ·30 | ·19 | ·96 | ·03 | ·19 | 7·5 | 35·1 | 2·29 | Grass, mainly green. |
| | | July, 1934 | ·043 | ·22 | ·09 | ·18 | trace | ·08 | 3·9 | 32·5 | 1·23 | Grass, mainly brown, leafy. |
| | | Nov., 1934 | ·19 | ·25 | ·12 | 1·36 | ·08 | ·28 | 15·7 | 34·2 | 3·10 | Grass, green, leafy. |
| | | Dec., 1934 | ·12 | ·33 | ·17 | 1·46 | ·10 | ·35 | 10·3 | 29·5 | 3·22 | Grass, green, short. |
| | | April, 1935 | ·11 | ·28 | ·16 | ·98 | ·07 | ·15 | 8·2 | 29·4 | 2·47 | Grass, mainly green, short. |
| Bally-Rush....... | Umzimkulu.... | Jan., 1934 | ·093 | ·29 | ·17 | ·88 | ·02 | ·29 | 5·1 | 40·3 | 2·05 | Grass. |
| | | April, 1934 | ·07 | ·41 | ·14 | ·75 | ·02 | ·29 | 4·9 | 35·8 | 2·35 | Grass, leafy. |
| | | June, 1934 | ·04 | ·22 | ·12 | ·37 | trace | ·12 | 4·0 | 35·3 | 1·58 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·067 | ·22 | ·22 | ·43 | trace | ·10 | 4·7 | 34·2 | 1·48 | Grass, mainly brown, leafy. |
| | | Mar., 1935 | ·097 | ·22 | ·16 | ·92 | trace | ·19 | 7·0 | 33·4 | 2·47 | Grass, green, short. |
| | | June, 1935 | ·044 | ·21 | ·13 | ·65 | trace | ·09 | 5·2 | 32·8 | 2·10 | Grass, mainly green, short. |
| Koppieskraal..... | Mt. Currie..... | Nov., 1933 | ·14 | ·26 | ·10 | 1·02 | ·06 | ·21 | 5·2 | 34·6 | 2·64 | Grass. |
| | | Feb., 1934 | ·17 | ·37 | ·24 | 1·93 | ·02 | ·33 | 7·9 | 32·3 | 4·39 | Grass, mainly green, short. |
| | | Aug., 1934 | ·05 | ·44 | ·12 | ·18 | trace | ·02 | 2·3 | 34·5 | 1·77 | Grass, mainly brown, leafy. |
| | | Nov., 1934 | ·19 | ·28 | ·14 | 1·51 | trace | ·35 | 13·1 | 30·3 | 2·91 | Grass, green, short. |
| | | Mar., 1935 | ·10 | ·45 | ·12 | ·59 | ·02 | ·13 | 4·8 | 33·8 | 2·27 | Grass, mainly green, leafy. |
| | | June, 1935 | ·06 | ·31 | ·11 | ·22 | trace | ·07 | 3·2 | 39·0 | 1·59 | Grass, brown, leafy. |

AREA 3 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Strathneva**....... | **Mt. Currie**..... | Dec., 1933 | ·13 | ·37 | ·16 | 1·25 | trace | ·18 | 7·5 | 31·8 | 2·84 | Grass, mainly green, short. |
| | | Mar., 1934 | ·11 | ·36 | ·17 | ·88 | ·01 | ·14 | 5·9 | 33·3 | 2·40 | Grass, mainly green, short. |
| | | June, 1934 | ·047 | ·37 | ·12 | ·52 | ·01 | ·11 | 3·1 | 33·2 | 2·03 | Grass, mainly brown, leafy. |
| | | Dec., 1934 | ·14 | ·36 | ·14 | 1·30 | ·03 | ·23 | 8·4 | 31·1 | 2·87 | Grass, green, short. |
| | | April, 1935 | ·087 | ·49 | ·16 | ·47 | ·16 | ·16 | 5·0 | 30·0 | 2·58 | Grass, mainly green, leafy. |
| | | July, 1935 | ·056 | ·40 | ·11 | ·18 | trace | ·07 | 2·2 | 35·0 | 1·71 | Grass, brown, leafy. |
| **Kokstad Commonage** | **Mt. Currie**..... | Jan., 1934 | ·15 | ·29 | ·12 | 1·38 | ·02 | ·22 | — | 38·3 | 2·69 | Grass, mainly green, short. |
| | | April, 1934 | ·088 | ·26 | ·12 | ·99 | ·02 | ·22 | 4·3 | 35·4 | 2·26 | Grass, mainly green, leafy. |
| | | July, 1934 | ·038 | ·36 | ·10 | ·17 | trace | ·04 | 2·5 | 34·6 | 1·38 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·08 | ·26 | ·07 | ·36 | trace | ·10 | 4·7 | 33·1 | 1·54 | Grass, mainly brown, leafy. |
| | | Jan., 1935 | ·12 | ·33 | ·16 | 1·22 | ·02 | ·22 | 8·0 | 32·9 | 2·70 | Grass, green, short. |
| | | Feb., 1935 | ·11 | ·29 | ·12 | ·78 | ·05 | ·25 | 5·2 | 32·7 | 2·07 | Grass, mainly green, leafy. |
| | | May, 1935 | ·078 | ·32 | ·08 | ·23 | ·02 | ·07 | 3·5 | 36·2 | 1·39 | Grass, brown, leafy. |
| | | Aug., 1935 | ·11 | ·32 | ·09 | ·15 | trace | ·05 | 3·0 | 33·5 | 1·40 | Grass, brown, leafy. |
| | | Oct., 1935 | ·074 | ·24 | ·07 | ·32 | trace | ·08 | 4·0 | 33·2 | 1·74 | Grass, brown, leafy. |
| **Drummond Elliot** | **Matatiele**...... | Nov., 1933 | ·082 | ·34 | ·11 | ·34 | ·01 | ·10 | 3·4 | 37·4 | 2·11 | Grass, mainly brown. |
| | | Feb., 1934 | ·18 | ·30 | ·14 | 1·08 | ·02 | ·16 | 7·6 | 35·1 | 2·71 | Grass. |
| | | May, 1934 | ·095 | ·27 | ·09 | ·43 | ·02 | ·10 | 4·2 | 35·9 | 1·69 | Grass, long. |
| | | Aug., 1934 | ·04 | ·35 | ·14 | ·22 | trace | ·02 | 2·6 | 39·9 | 1·50 | Grass, brown, leafy. |
| | | Nov., 1934 | ·20 | ·28 | ·11 | 2·00 | trace | ·56 | 10·9 | 33·8 | 4·06 | Grass, green, leafy. |
| | | Feb., 1935 | ·15 | ·24 | ·08 | ·78 | ·01 | ·10 | 4·5 | 32·8 | 1·89 | Grass, mainly green. |
| | | May, 1935 | ·14 | ·29 | ·08 | ·33 | ·02 | ·04 | 2·7 | 34·3 | 1·47 | Grass, mainly brown, leafy. |
| **Try Again**....... | **Matatiele**...... | Dec., 1933 | ·22 | ·26 | ·17 | 1·98 | ·19 | ·21 | 8·0 | 38·7 | 4·11 | Grass, green. |
| | | Mar., 1934 | ·23 | ·23 | ·16 | 1·62 | ·05 | ·37 | 6·5 | 37·6 | 3·75 | Grass, green. |
| | | June, 1934 | ·11 | ·29 | ·09 | ·43 | ·01 | ·18 | 4·5 | 36·4 | 1·60 | Grass, brown, leafy. |
| | | Sept., 1934 | ·065 | ·28 | ·07 | ·18 | trace | ·04 | 3·8 | 33·6 | 1·30 | Grass, brown, leafy. |
| | | Dec., 1934 | ·19 | ·29 | ·13 | 1·39 | ·28 | ·32 | 7·8 | 36·5 | 3·32 | Grass, green, leafy. |
| | | Mar., 1935 | ·17 | ·34 | ·09 | ·61 | ·02 | ·09 | 5·3 | 34·9 | 2·08 | Grass, mainly green, leafy. |
| | | June, 1935 | ·10 | ·24 | ·11 | ·43 | ·02 | ·05 | 3·9 | 40·7 | 1·62 | Grass, mainly brown. |
| | | Sept., 1935 | ·057 | ·22 | ·05 | ·35 | ·02 | ·09 | 4·4 | 31·4 | 1·39 | Grass. |
| **Maartenliefeldt**... | **Matatiele**...... | Jan., 1934 | ·17 | ·24 | ·11 | 1·83 | ·04 | ·13 | 7·6 | 38·0 | 3·58 | Grass, mainly green. |
| | | April, 1934 | ·15 | ·31 | ·13 | 1·52 | ·07 | ·77 | 10·1 | 26·4 | 3·91 | Grass, mainly green. |
| | | July, 1934 | ·11 | ·26 | ·10 | ·25 | trace | ·02 | 3·1 | 33·5 | 1·64 | Grass, brown, leafy. |
| | | Oct., 1934 | ·076 | ·18 | ·05 | ·22 | trace | ·03 | 4·5 | 34·7 | 1·34 | Grass, leafy. |
| | | Jan., 1935 | ·14 | ·24 | ·08 | ·85 | ·02 | ·12 | 7·1 | 37·3 | 2·01 | Grass, green. |
| | | April, 1935 | ·13 | ·25 | ·08 | ·54 | ·02 | ·08 | 4·7 | 36·4 | 1·67 | Grass, long. |
| | | Oct., 1935 | ·05 | ·19 | ·06 | ·34 | trace | ·04 | 3·0 | 39·0 | 1·11 | Grass, mainly brown. |
| **Setaba Weila**..... | **Matatiele**...... | Nov., 1933 | ·10 | ·26 | ·09 | ·69 | ·01 | ·13 | 5·7 | 34·9 | 1·96 | Grass, leafy. |
| | | Feb., 1934 | ·14 | ·30 | ·12 | 1·14 | ·24 | ·25 | 7·3 | 32·9 | 2·45 | Grass, mainly green. |
| | | Aug., 1934 | ·055 | ·36 | ·13 | ·19 | trace | ·01 | 2·2 | 35·6 | 1·49 | Grass, brown, leafy. |
| | | Mar., 1935 | ·11 | ·36 | ·16 | ·56 | trace | ·11 | 6·4 | 33·0 | 1·94 | Grass, mainly green, leafy. |
| | | Aug., 1935 | ·07 | ·36 | ·13 | ·31 | ·01 | ·04 | 3·3 | 32·7 | 1·57 | Grass, brown, leafy. |

### AREA 3 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Cross Roads**..... | **Matatiele**...... | Dec., 1933 | ·18 | ·19 | ·10 | 1·29 | ·03 | ·22 | 11·6 | 39·7 | 2·71 | Grass, green, leafy. |
| | | Mar., 1934 | ·14 | ·33 | ·10 | ·75 | ·02 | ·12 | 6·0 | 37·4 | 2·21 | Grass, mainly green, leafy. |
| | | June, 1934 | ·062 | ·41 | ·09 | ·27 | trace | ·06 | 2·7 | 33·4 | 1·68 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·053 | ·33 | ·09 | ·12 | trace | ·02 | 2·7 | 34·5 | 1·31 | Grass, brown, leafy. |
| | | Mar., 1935 | ·13 | ·34 | ·09 | ·72 | trace | ·14 | 5·7 | 35·0 | 1·93 | Grass, green, leafy. |
| | | July, 1935 | ·084 | ·32 | ·08 | ·32 | ·01 | ·05 | 3·1 | 33·7 | 1·43 | Grass, brown, leafy. |
| | | Oct., 1935 | ·12 | ·32 | ·12 | ·72 | ·02 | ·11 | 6·5 | 32·0 | 2·09 | Grass, leafy. |
| **Merino Walk**..... | **Matatiele**...... | Jan., 1934 | ·28 | ·26 | ·13 | 1·54 | ·06 | ·28 | 10·8 | 37·8 | 3·38 | Grass, green, leafy. |
| | | April, 1934 | ·10 | ·47 | ·16 | ·66 | ·03 | ·16 | 5·5 | 31·6 | 2·16 | Grass, mainly green, leafy. |
| | | Aug., 1934 | ·046 | ·36 | — | — | trace | ·03 | 4·1 | 35·1 | 1·32 | Grass, mainly brown, leafy. |
| | | Nov., 1934 | ·16 | ·35 | ·14 | 1·37 | trace | ·34 | 8·2 | 34·1 | 2·95 | Grass, green. |
| | | April, 1935 | ·096 | ·40 | ·13 | ·74 | ·03 | ·13 | 5·4 | 31·3 | 1·99 | Grass, mainly green, leafy. |
| | | Sept., 1935 | ·07 | ·38 | ·06 | ·47 | ·03 | ·09 | 4·0 | 35·6 | 1·77 | Grass, brown, leafy. |
| **Mt. Ayliff Commonage** | **Mt. Ayliff**..... | Nov., 1933 | ·16 | ·38 | ·15 | 1·72 | trace | ·64 | 8·4 | 37·5 | 4·43 | Grass. |
| | | Feb., 1934 | ·18 | ·39 | ·16 | ·81 | ·03 | ·50 | 5·4 | 37·4 | 2·40 | Grass, mainly green. |
| | | June, 1934 | ·054 | ·41 | ·13 | ·28 | ·01 | ·09 | 2·6 | 33·8 | 1·57 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·055 | ·33 | ·14 | ·24 | ·01 | ·07 | 4·1 | 35·4 | 1·37 | Grass, mainly brown, leafy. |
| | | Dec., 1934 | ·07 | ·29 | ·13 | ·70 | trace | ·22 | 5·3 | 34·4 | 1·90 | Grass, mainly green. |
| | | Mar., 1935 | ·14 | ·31 | ·20 | ·92 | ·03 | ·11 | 5·6 | 37·0 | 2·38 | Grass, green. |
| | | June, 1935 | ·057 | ·51 | ·21 | ·48 | trace | ·13 | 3·7 | 34·2 | 2·34 | Grass, mainly green, long. |
| | | Nov., 1935 | ·05 | ·33 | ·16 | ·37 | trace | ·07 | 3·2 | 37·9 | 1·78 | Grass, mainly brown, leafy. |
| **Betshwana Location** | **Mt. Ayliff**..... | Dec., 1933 | ·13 | ·29 | ·20 | 1·18 | ·03 | 30 | 10·7 | 30·9 | 3·09 | Grass, mainly green. |
| | | Mar., 1934 | ·10 | ·38 | ·14 | ·76 | ·02 | ·18 | 6·1 | 33·4 | 2·21 | Grass, mainly green. |
| | | April, 1934 | ·08 | ·34 | ·14 | ·72 | ·02 | ·16 | 5·4 | 32·8 | 2·09 | Grass, leafy. |
| | | Jan., 1935 | ·065 | ·23 | ·12 | ·69 | ·04 | ·17 | 5·0 | 33·5 | 1·71 | Grass, mainly green. |
| | | April, 1935 | ·06 | ·49 | ·22 | ·39 | trace | ·16 | 4·1 | 32·9 | 2·14 | Grass, green, long. |
| | | Aug., 1935 | ·083 | ·44 | ·20 | ·30 | trace | ·09 | 2 4 | 34·0 | 2·03 | Grass, leafy. |
| **Ngwegweni Location** | **Mt. Ayliff**..... | Jan., 1934 | ·12 | ·18 | ·13 | 1·65 | trace | ·19 | 7·7 | 36·4 | 3·20 | Grass, mainly green. |
| | | May, 1934 | ·046 | ·33 | ·14 | ·34 | 01 | ·10 | 3·3 | 33·8 | 1·56 | Grass, mainly green, long. |
| | | July, 1934 | ·035 | ·29 | ·11 | ·16 | trace | ·02 | 2·8 | 33·7 | 1·27 | Grass, brown, leafy. |
| | | Aug., 1934 | ·047 | ·26 | ·13 | ·26 | trace | ·04 | 3·7 | 31·6 | 1·31 | Grass, brown, leafy. |
| | | Oct., 1934 | ·089 | ·16 | ·22 | ·80 | ·02 | ·10 | 5·3 | 35·6 | 1·84 | Grass, mainly green. |
| | | Feb., 1935 | ·13 | ·32 | ·18 | ·96 | ·08 | ·15 | 6·4 | 35·9 | 2·42 | Grass, green. |
| | | May, 1935 | ·055 | ·58 | ·30 | 32 | trace | ·07 | 3·1 | 35·8 | 2·20 | Grass, mainly green. |
| | | Aug., 1935 | ·077 | ·46 | ·23 | ·18 | ·01 | ·07 | 1·8 | 34·4 | 1·65 | Grass, brown, leafy. |
| | | Oct., 1935 | ·08 | ·38 | ·24 | ·54 | ·01 | ·12 | 4·1 | 36·4 | 2·19 | Grass, leafy. |
| **Labueweni Location** | **Mt. Frere**..... | Nov., 1933 | ·14 | ·31 | ·13 | 1·04 | ·06 | ·27 | 10·5 | 31·7 | 3·18 | Grass, mainly green. |
| | | May, 1934 | ·055 | ·39 | ·13 | ·51 | trace | ·19 | 4·0 | 37·3 | 1·70 | Grass, leafy. |
| | | Nov., 1934 | ·14 | ·30 | ·13 | 1·59 | trace | ·41 | 9·2 | 34·5 | 3·03 | Grass, green, leafy. |
| | | Feb., 1935 | ·13 | ·37 | ·18 | 1·44 | trace | ·11 | 7·9 | 33·1 | 3·10 | Grass, green, leafy. |
| | | May, 1935 | ·074 | ·45 | ·14 | ·39 | ·01 | ·09 | 3·7 | 31·3 | 1·80 | Grass, leafy. |
| | | Aug., 1935 | ·047 | ·28 | ·06 | ·18 | ·02 | ·05 | 2·3 | 36·4 | 1·02 | Grass, brown, leafy. |

## AREA 3 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dlodela.......... | Mt. Frere...... | Dec., 1933 | ·12 | ·34 | ·13 | 1·24 | ·05 | ·32 | 8·1 | 33·7 | 2·58 | Grass, mainly green, short. |
| | | Mar., 1934 | ·097 | ·31 | ·14 | ·82 | ·02 | ·20 | 7·6 | 33·3 | 2·12 | Grass, mainly green, short. |
| | | June, 1934 | ·045 | ·34 | ·10 | ·32 | ·01 | ·05 | 3·0 | 34·5 | 1·45 | Grass, mainly brown, leafy. |
| | | Dec., 1934 | ·12 | ·30 | ·11 | 1·13 | ·03 | ·23 | 7·2 | 32·9 | 2·36 | Grass, green, leafy. |
| | | Mar., 1935 | ·083 | ·22 | ·10 | ·74 | ·01 | ·17 | 6·8 | 33·8 | 2·39 | Grass, green, short. |
| | | June, 1935 | ·05 | ·36 | ·11 | ·22 | trace | ·09 | 2·9 | 33·8 | 1·57 | Grass, brown, short. |
| | | Sept., 1935 | ·047 | ·28 | ·04 | ·18 | ·03 | ·08 | 3·0 | 37·4 | 1·27 | Grass, brown, leafy. |
| Mt. Frere Commonage | Mt. Frere...... | Jan., 1934 | ·11 | ·31 | ·14 | 1·26 | ·01 | ·20 | 6·5 | 33·4 | 2·68 | Grass, mainly green, short. |
| | | April, 1934 | ·098 | ·23 | ·13 | ·88 | ·02 | ·18 | 6·9 | 37·8 | 2·21 | Grass, mainly green, short. |
| | | Oct., 1934 | ·05 | ·24 | ·08 | ·18 | ·01 | ·04 | 4·1 | 31·3 | 1·32 | Grass, leafy. |
| | | Jan., 1935 | ·10 | ·44 | ·13 | ·95 | ·16 | ·36 | 6·1 | 35·1 | 2·53 | Grass, green, leafy. |
| | | April, 1935 | ·083 | ·31 | ·11 | ·63 | ·01 | ·11 | 3·3 | 34·8 | 1·46 | Grass, leafy. |
| | | July, 1935 | ·068 | ·25 | ·07 | ·19 | trace | ·08 | 3·2 | 37·1 | 1·66 | Grass, brown, short. |
| | | Oct., 1935 | ·04 | ·23 | ·04 | ·07 | ·02 | ·01 | 2·6 | 40·2 | 0·89 | Grass, brown, leafy. |
| Ezilindene Location | Mt. Fletcher... | Nov., 1933 | ·09 | ·21 | ·08 | ·59 | ·01 | ·22 | 5·8 | 34·5 | 2·06 | Grass, brown. |
| | | Feb., 1934 | ·13 | ·24 | ·18 | 1·65 | ·03 | ·31 | 7·8 | 32·3 | 3·05 | Grass, green. |
| | | May, 1934 | ·046 | ·39 | ·13 | 1·05 | ·03 | ·22 | 3·6 | 35·6 | 2·08 | Grass, leafy. |
| | | Aug., 1934 | ·06 | ·32 | ·12 | ·27 | trace | ·06 | 3·4 | 36·4 | 1·42 | Grass, mainly brown, leafy. |
| | | Nov., 1934 | ·084 | ·22 | ·08 | ·94 | ·02 | ·19 | 6·7 | 33·1 | 1·81 | Grass, mainly green, leafy. |
| | | Feb., 1935 | ·074 | ·28 | ·10 | ·87 | trace | ·14 | 5·2 | 34·2 | 1·87 | Grass, green, leafy. |
| | | May, 1935 | ·078 | ·30 | ·08 | ·43 | trace | ·08 | 3·5 | 34·7 | 1·42 | Grass, leafy. |
| | | Aug., 1935 | ·074 | ·24 | ·09 | ·33 | ·03 | ·12 | 2·8 | 35·6 | 1·50 | Grass, mainly brown, leafy. |
| Mfanta Location.. | Mt. Fletcher... | Dec., 1933 | ·13 | ·29 | ·15 | 1·57 | trace | ·29 | 9·3 | 33·2 | 3·53 | Grass, mainly green, short. |
| | | Mar., 1934 | ·08 | ·24 | ·10 | ·91 | ·01 | ·23 | 6·4 | 36·6 | 2·09 | Grass, green, short. |
| | | June, 1934 | ·046 | ·34 | ·10 | ·52 | ·04 | ·15 | 3·2 | 34·0 | 1·87 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·07 | ·42 | ·10 | ·36 | trace | ·07 | 3·7 | 35·1 | 1·20 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·05 | ·21 | ·06 | ·34 | trace | ·07 | 3·7 | 37·2 | 1·21 | Grass, leafy. |
| | | Dec., 1934 | — | ·29 | ·12 | 1·28 | trace | — | 7·8 | 34·6 | 2·59 | Grass, green, leafy. |
| | | Mar., 1935 | ·077 | ·26 | ·10 | ·61 | trace | ·09 | 5·6 | 34·0 | 1·66 | Grass, green, leafy. |
| | | June, 1935 | ·052 | ·24 | ·08 | ·29 | trace | ·10 | 3·0 | 36·1 | 1·42 | Grass, mainly brown, leafy. |
| Castle Rocks Location | Mt. Fletcher... | Jan., 1934 | ·10 | ·27 | ·12 | 1·21 | ·08 | ·24 | 7·4 | 35·1 | 2·81 | Grass, mainly green. |
| | | April, 1934 | ·093 | ·27 | ·10 | ·79 | trace | ·16 | 6·2 | 33·9 | 1·74 | Grass, mainly green, leafy. |
| | | July, 1934 | ·032 | ·32 | ·08 | ·49 | trace | ·11 | 3·3 | 35·5 | 1·57 | Grass, mainly brown, leafy. |
| | | Jan., 1935 | — | ·30 | ·11 | 1·31 | ·03 | — | 7·4 | 34·9 | 2·61 | Grass, green, leafy. |
| | | April, 1935 | ·066 | ·30 | ·10 | ·74 | ·02 | ·10 | 5·0 | 33·2 | 1·88 | Grass, mainly green, leafy. |
| | | July, 1935 | ·092 | ·23 | ·08 | ·34 | ·02 | ·13 | 3·3 | 38·7 | 1·43 | Grass, mainly brown, leafy. |

## AREA 4.

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wheatlands...... | Port Shepstone | Dec., 1933 | ·13 | ·20 | ·17 | 1·65 | ·35 | ·69 | 6·0 | 38·5 | 4·00 | Grass, mainly green. |
| | | Mar., 1934 | ·12 | ·27 | ·11 | 1·07 | ·31 | ·47 | 7·1 | 39·3 | 3·37 | Grass, mainly green, short. |
| | | June, 1934 | ·06 | ·21 | ·08 | ·54 | ·15 | ·34 | 5·1 | 39·9 | 1·99 | Grass, mainly green. |
| | | Aug., 1934 | ·087 | ·23 | ·13 | ·91 | ·24 | ·40 | 8·3 | 37·6 | 2·80 | Grass, mainly green. |
| | | Feb., 1935 | ·066 | ·20 | ·12 | ·98 | ·19 | ·35 | 5·1 | 39·6 | 2·32 | Grass, green, long. |
| | | Aug., 1935 | ·052 | ·22 | ·10 | ·80 | ·25 | ·58 | 3·5 | 39·8 | 2·79 | Grass, mainly brown. |
| Briarglen........ | Port Shepstone | Jan., 1934 | ·13 | ·25 | ·15 | 1·31 | ·18 | ·52 | 13·5 | 38·8 | 3·33 | Grass, mainly green. |
| | | April, 1934 | ·08 | ·22 | ·13 | ·73 | ·16 | ·38 | 5·1 | 40·8 | 2·36 | Grass, short. |
| | | Oct., 1934 | ·083 | ·33 | ·22 | ·93 | ·16 | ·40 | 6·8 | 34·9 | 3·03 | Grass, green. |
| | | Mar., 1935 | ·084 | ·20 | ·13 | ·99 | ·24 | ·94 | 5·2 | 41·3 | 2·94 | Grass, mainly green. |
| | | June, 1935 | ·12 | ·25 | ·11 | ·84 | ·07 | ·05 | 5·1 | 39·5 | 2·60 | Grass, leafy. |
| | | Sept., 1935 | ·06 | ·17 | ·11 | ·79 | ·21 | ·62 | 3·9 | 39·5 | 2·70 | Grass. |
| Fountain Hill.... | Port Shepstone | Nov., 1933 | ·14 | ·19 | ·14 | 1·41 | ·23 | ·40 | 12·6 | 35·0 | 3·16 | Grass, green, leafy. |
| | | Feb., 1934 | ·09 | ·21 | ·13 | 1·11 | ·18 | ·40 | 6·1 | 37·1 | 2·57 | Grass, green, leafy. |
| | | May, 1934 | ·077 | ·23 | ·15 | ·75 | ·09 | ·35 | 6·7 | 35·8 | 2·10 | Grass, mainly green, leafy. |
| | | Aug., 1934 | ·13 | ·27 | ·14 | 1·01 | ·16 | ·31 | 8·1 | 35·3 | 2·61 | Grass, mainly green. |
| | | Nov., 1934 | ·16 | ·28 | ·17 | 1·33 | ·21 | ·49 | 11·4 | 31·5 | 3·35 | Grass, green, leafy. |
| | | Feb., 1935 | ·11 | ·21 | ·12 | 1·20 | ·10 | ·22 | 7·7 | 34·0 | 2·31 | Grass, green, leafy. |
| | | May, 1935 | ·12 | ·30 | ·16 | ·89 | ·15 | ·27 | 6·7 | 34·6 | 2·49 | Grass, green, leafy. |
| | | Aug., 1935 | ·058 | ·28 | ·13 | ·90 | ·23 | ·40 | 7·2 | 33·9 | 2·71 | Grass, green, leafy. |
| Fredheim........ | Port Shepstone | Dec., 1933 | ·13 | ·24 | ·20 | 1·57 | ·19 | ·55 | 10·3 | 34·4 | 3·47 | Grass, mainly green, leafy. |
| | | Mar., 1934 | ·093 | ·32 | ·22 | ·61 | ·07 | ·32 | 6·3 | 38·4 | 2·10 | Grass, mainly green. |
| | | June, 1934 | ·09 | ·30 | ·17 | ·98 | ·26 | ·40 | 7·8 | 33·5 | 2·75 | Grass, green, leafy. |
| | | Sept., 1934 | ·14 | ·19 | ·20 | 1·08 | ·38 | ·75 | 12·6 | 36·4 | 4·06 | Grass, green, leafy. |
| | | Dec., 1934 | — | ·24 | ·19 | 1·02 | ·19 | — | 9·6 | 32·7 | 2·62 | Grass, green, leafy. |
| | | Mar., 1935 | ·086 | ·32 | ·16 | ·75 | ·10 | ·26 | 6·5 | 33·5 | 2·09 | Grass, green, leafy. |
| | | June, 1935 | ·11 | ·41 | ·19 | 1·15 | ·17 | ·52 | 9·8 | 31·4 | 3·58 | Grass, green, leafy. |
| | | Sept., 1935 | ·21 | ·32 | ·19 | 2·12 | ·25 | ·93 | 16·5 | 30·6 | 7·04 | Grass, green, short. |
| Ocean View...... | Port Shepstone | Jan., 1934 | ·13 | ·22 | ·17 | 1·29 | ·24 | ·44 | 8·7 | 34·1 | 3·16 | Grass, mainly green. |
| | | April, 1934 | ·10 | ·26 | ·16 | ·93 | ·11 | ·31 | 7·3 | 36·8 | 2·52 | Grass, mainly green, leafy. |
| | | July, 1934 | ·083 | ·27 | ·17 | — | ·28 | ·52 | 6·8 | 35·8 | 2·84 | Grass, mainly green, leafy. |
| | | Oct., 1934 | ·11 | ·23 | ·21 | 1·40 | ·47 | ·41 | 11·2 | 33·2 | 3·70 | Grass, green, leafy. |
| | | Jan., 1935 | ·13 | ·23 | ·19 | 1·63 | ·40 | ·60 | 9·7 | 36·4 | 3·93 | Grass, green, leafy. |
| | | April, 1935 | ·12 | ·26 | ·17 | 1·23 | ·28 | ·57 | 12·3 | 35·7 | 3·31 | Grass, green, leafy. |
| | | July, 1935 | ·15 | ·30 | ·25 | 1·09 | ·42 | ·70 | 11·2 | 31·9 | 4·13 | Grass, green, leafy. |
| | | Oct., 1935 | ·12 | ·23 | ·17 | 1·20 | ·39 | ·67 | 9·1 | 33·1 | 4·17 | Grass, green, short. |
| Southbroom...... | Port Shepstone | Nov., 1933 | ·23 | ·31 | ·15 | 2·04 | ·32 | ·86 | 12·4 | 34·8 | 4·85 | Grass, green, short. |
| | | May, 1934 | ·068 | ·21 | ·10 | ·68 | ·15 | ·47 | 5·5 | 43·1 | 2·46 | Grass, mainly green. |
| | | Sept., 1934 | ·096 | ·30 | ·11 | ·83 | ·38 | ·43 | 8·7 | 36·3 | 2·40 | Grass, green. |
| | | April, 1935 | ·063 | ·18 | ·14 | 1·11 | ·31 | ·60 | 6·7 | 38·7 | 2·94 | Grass, mainly green. |
| | | July, 1935 | ·063 | ·21 | ·16 | ·47 | ·18 | ·16 | 3·7 | 37·0 | 2·31 | Grass. |
| | | Oct., 1935 | ·053 | ·17 | ·11 | ·63 | ·15 | ·39 | 4·3 | 39·2 | 2·29 | Grass, mainly green. |

AREA 4 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kenterton....... | Umzinto....... | Nov., 1933 | ·16 | ·26 | ·14 | 1·45 | ·33 | ·74 | 12·9 | 33·0 | 3·84 | Grass, green, leafy. |
| | | Feb., 1934 | ·095 | ·14 | ·08 | 1·05 | ·07 | ·18 | 7·2 | 41·4 | 2·07 | Grass, mainly green. |
| | | May, 1934 | ·055 | ·14 | ·05 | ·37 | ·04 | ·09 | 3·7 | 41·3 | 1·27 | Grass. |
| | | Aug., 1934 | ·036 | ·16 | ·05 | ·22 | ·01 | ·04 | 3·1 | 43·3 | 0·89 | Grass, mainly brown. |
| | | Nov., 1934 | ·14 | ·22 | ·12 | 1·47 | ·13 | ·57 | 12·0 | 32·8 | 3·25 | Grass, green. |
| | | April, 1935 | ·16 | ·28 | ·32 | 2·39 | ·11 | ·45 | 6·8 | 37·8 | 4·94 | Grass. |
| Melbourne....... | Umzinto....... | Dec., 1933 | ·092 | ·19 | ·15 | 1·21 | ·09 | ·35 | 7·5 | 36·6 | 2·53 | Grass, mainly green. |
| | | Mar., 1934 | ·062 | ·12 | ·07 | ·62 | ·05 | ·17 | 3·4 | 44·1 | 1·31 | Grass, green, long. |
| | | June, 1934 | ·14 | ·26 | ·08 | 1·32 | ·11 | ·33 | 5·9 | 38·1 | 3·00 | Grass, mainly green. |
| | | Dec., 1934 | ·23 | ·20 | ·11 | 1·77 | ·17 | ·32 | 13·4 | 37·5 | 3·78 | Grass, green. |
| | | May, 1935 | ·08 | ·27 | ·12 | 1·03 | ·14 | ·52 | 4·9 | 39·9 | 2·73 | Grass, mainly green. |
| Sutherland....... | Umzinto....... | Jan., 1934 | ·09 | ·24 | ·13 | 1·06 | ·08 | ·28 | 6·5 | 37·9 | 2·66 | Grass, mainly green. |
| | | July, 1934 | ·10 | ·15 | ·07 | ·42 | ·11 | ·22 | 4·9 | 38·5 | 1·76 | Grass. |
| | | Oct., 1934 | ·13 | ·16 | ·08 | ·85 | ·11 | ·33 | 7·8 | 36·8 | 2·47 | Grass, mainly green. |
| | | June, 1935 | ·057 | ·23 | ·18 | ·88 | ·10 | ·36 | 5·1 | 37·4 | 2·25 | Grass, mainly green. |
| Park Rynnie..... | Umzinto....... | Nov., 1933 | ·087 | ·19 | ·13 | ·82 | ·23 | ·40 | 8·0 | 38·4 | 2·65 | Grass, green, leafy. |
| | | Feb., 1934 | ·19 | ·25 | ·09 | 1·41 | ·14 | ·44 | 7·9 | 39·0 | 3·45 | Grass, mainly green. |
| | | May, 1934 | ·14 | ·24 | ·08 | ·86 | ·13 | ·35 | 6·0 | 40·3 | 2·38 | Grass, mainly green. |
| | | April, 1935 | ·056 | ·18 | ·15 | ·35 | ·17 | ·16 | 3·9 | 35·7 | 1·70 | Grass, leafy. |
| | | July, 1935 | ·048 | ·16 | ·13 | ·22 | ·16 | ·25 | 3·6 | 35·2 | 1·46 | Grass, leafy. |
| | | Oct., 1935 | ·05 | ·18 | ·17 | ·29 | ·17 | ·22 | 4·8 | 41·5 | 1·90 | Grass, leafy. |
| Monte Vedio..... | Umzinto....... | Dec., 1933 | ·10 | ·17 | ·09 | ·99 | ·10 | ·24 | 6·6 | 38·9 | 2·64 | Grass, mainly green, short. |
| | | Mar., 1934 | ·10 | ·16 | ·11 | 1·37 | ·11 | ·34 | 8·1 | 36·2 | 2·89 | Grass, mainly green, short. |
| | | June, 1934 | ·09 | ·25 | ·12 | ·90 | ·08 | ·41 | 6·1 | 38·4 | 2·29 | Grass. |
| | | Sept., 1934 | ·15 | ·21 | ·08 | ·56 | ·08 | ·16 | 6·8 | 37·3 | 1·84 | Grass, mainly green. |
| | | May, 1935 | ·08 | ·20 | ·18 | ·42 | ·15 | ·26 | 4·3 | 38·8 | 1·82 | Grass, mainly green. |
| | | Aug., 1935 | ·057 | ·19 | ·16 | ·40 | ·14 | ·24 | 4·0 | 36·9 | 1·91 | Grass, mainly green, leafy. |
| Imbelebele....... | Umzinto....... | Jan., 1934 | ·14 | ·18 | ·15 | 1·49 | ·09 | ·44 | 8·9 | 39·6 | 3·27 | Grass, mainly green. |
| | | April, 1934 | ·14 | ·33 | ·11 | 1·15 | ·13 | ·40 | 7·3 | 39·3 | 2·88 | Grass, mainly green. |
| | | July, 1934 | ·10 | ·16 | ·07 | ·44 | ·03 | ·08 | 5·9 | 37·2 | 1·53 | Grass, mainly green, short. |
| | | Oct., 1934 | ·14 | ·21 | ·07 | ·86 | ·13 | ·27 | 6·3 | 38·0 | 2·17 | Grass, mainly green. |
| | | June, 1935 | ·06 | ·18 | ·16 | ·35 | ·11 | ·31 | 5·0 | 36·1 | 1·83 | Grass, leafy. |
| | | Sept., 1935 | ·053 | ·18 | ·16 | ·27 | ·23 | ·44 | 4·5 | 34·6 | 2·20 | Grass, leafy. |
| Rooivaal......... | Alfred......... | Nov., 1933 | ·093 | ·22 | ·17 | ·55 | ·09 | ·22 | 8·9 | 33·7 | 2·07 | Grass. |
| | | June, 1934 | ·052 | ·26 | ·16 | ·46 | ·02 | ·13 | 4·3 | 32·5 | 1·60 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·05 | ·17 | ·12 | ·25 | ·02 | ·11 | 4·0 | 37·7 | 1·21 | Grass, mainly brown, leafy. |
| | | Jan., 1935 | ·088 | ·28 | ·19 | ·90 | ·07 | ·25 | 7·6 | 33·6 | 2·21 | Grass, green, leafy. |
| | | Mar., 1935 | ·086 | ·29 | ·17 | ·58 | ·11 | ·17 | 6·0 | 32·6 | 2·20 | Grass, green, leafy. |
| | | June, 1935 | ·067 | ·23 | ·13 | ·38 | trace | ·10 | 4·4 | 33·6 | 1·66 | Grass, mainly brown, short. |
| | | Aug., 1935 | ·06 | ·25 | ·09 | ·36 | ·05 | ·09 | 3·3 | 34·8 | 2·34 | Grass, mainly brown, short. |
| | | Oct., 1935 | ·09 | ·21 | ·11 | ·76 | ·03 | ·19 | 7·9 | 35·1 | 2·21 | Grass, mainly green, short. |

## AREA 4 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| The Pastures..... | Alfred......... | Feb., 1934 | ·087 | ·26 | ·15 | ·90 | ·21 | ·24 | 7·8 | 35·8 | 2·61 | Grass, mainly green. |
| | | July, 1934 | ·045 | ·32 | ·15 | ·29 | ·03 | ·09 | 3·1 | 33·0 | 1·63 | Grass, mainly brown, leafy. |
| | | Nov., 1934 | ·055 | ·21 | ·09 | ·42 | ·04 | ·12 | 5·5 | 36·3 | 1·59 | Grass, mainly brown, leafy. |
| | | Feb., 1935 | ·092 | ·27 | ·18 | ·82 | ·14 | ·17 | 7·5 | 34·0 | 2·35 | Grass, green, leafy. |
| | | July, 1935 | ·067 | ·26 | ·13 | ·29 | ·04 | ·14 | 4·2 | 38·1 | 1·52 | Grass, leafy. |
| Cliffvale......... | Alfred......... | May, 1934 | ·065 | ·38 | ·27 | ·51 | ·03 | ·30 | 3·9 | 35·2 | 2·06 | Grass,leafy. |
| | | Oct.. 1934 | ·065 | ·17 | ·11 | ·33 | ·07 | ·22 | 4·1 | 37·1 | 1·30 | Grass, mainly brown, leafy. |
| | | April, 1935 | ·084 | ·28 | ·17 | ·58 | ·07 | ·17 | 5·9 | 33·2 | 1·82 | Grass, green, leafy. |
| Cibini Location... | Tabankulu..... | Jan., 1934 | — | ·27 | ·12 | 1·41 | ·02 | — | 8·2 | 33·1 | 3·38 | Grass. |
| | | April, 1934 | ·08 | ·27 | ·12 | ·77 | ·02 | ·14 | 5·3 | 31·4 | 1·97 | Grass, mainly brown, short. |
| | | July, 1934 | ·044 | ·34 | ·12 | ·18 | ·01 | ·04 | 3·2 | 33·3 | 1·48 | Grass, brown, leafy. |
| | | Oct., 1934 | ·052 | ·21 | ·06 | ·34 | ·01 | ·04 | 3·6 | 36·4 | 1·07 | Grass, brown. |
| | | Dec., 1934 | ·10 | ·33 | ·08 | ·92 | ·07 | ·15 | 7·0 | 33·6 | 2·32 | Grass, mainly green, leafy. |
| | | April, 1935 | ·11 | ·30 | ·11 | ·62 | trace | ·10 | 4·5 | 31·3 | 1·84 | Grass, mainly green, leafy. |
| Cacadu Location.. | Tabankulu..... | Feb., 1934 | ·072 | ·33 | ·17 | 1·31 | ·03 | ·29 | 5·8 | 39·1 | 3·08 | Grass, mainly green. |
| | | May, 1934 | ·10 | ·56 | ·20 | ·72 | ·03 | ·22 | 4·6 | 32·9 | 2·73 | Grass, mainly green, leafy. |
| | | Aug., 1934 | ·046 | ·24 | ·12 | ·36 | trace | ·12 | 3·1 | 36·3 | 1·38 | Grass, mainly brown, leafy. |
| | | Feb., 1935 | ·06 | ·24 | ·13 | ·59 | trace | ·09 | 4·2 | 32·6 | 1·89 | Grass, mainly green, leafy. |
| Ngcolo Location.. | Tabankulu..... | April, 1934 | ·088 | ·33 | ·15 | ·79 | ·02 | ·22 | 5·1 | 34·6 | 2·20 | Grass, mainly green, leafy. |
| | | June, 1934 | ·055 | ·44 | ·19 | ·19 | ·03 | ·12 | 3·7 | 33·2 | 1·76 | Grass, brown, leafy. |
| | | Sept., 1934 | ·054 | ·34 | ·20 | ·34 | ·02 | ·07 | 6·1 | 33·8 | 1·34 | Grass, mainly brown, leafy. |
| | | Jan., 1935 | ·067 | ·28 | ·13 | ·66 | ·04 | ·16 | 4·8 | 35·3 | 1·75 | Grass, mainly green, leafy. |
| | | Mar., 1935 | ·074 | ·38 | ·17 | ·70 | ·07 | ·23 | 5·5 | 35·7 | 1·99 | Grass, mainly green, leafy. |
| | | June, 1935 | ·089 | ·25 | ·16 | ·44 | trace | ·18 | 4·5 | 34·3 | 2·08 | Grass, short. |
| Ngwenyama Location | Tabankulu..... | Mar., 1934 | ·13 | ·32 | ·15 | 1·01 | ·02 | ·24 | 6·5 | 37·3 | 2·37 | Grass, mainly green. |
| | | Jan., 1935 | ·14 | ·29 | ·21 | 1·42 | trace | ·34 | 8·0 | 34·7 | 2·92 | Grass, green, leafy. |
| | | April, 1935 | ·12 | ·25 | ·06 | ·65 | ·02 | ·13 | 4·2 | 34·6 | 1·73 | Grass, leafy. |
| | | July, 1935 | ·09 | ·38 | ·10 | ·23 | ·02 | ·08 | 2·4 | 36·7 | 1·42 | Grass, brown, leafy. |
| | | Oct., 1935 | ·07 | ·25 | ·10 | ·51 | ·02 | ·14 | 4·5 | 41·2 | 1·67 | Grass, mainly green. |
| Lundine Location | Tabankulu..... | May, 1934 | ·15 | ·40 | ·10 | ·72 | ·04 | ·22 | 5·5 | 36·1 | 2·24 | Grass, mainly green. |
| | | Dec., 1934 | ·15 | ·31 | ·16 | 1·30 | ·05 | ·39 | 8·7 | 36·0 | 2·65 | Grass, mainly green, leafy. |
| | | Mar., 1935 | ·088 | ·21 | ·10 | ·79 | ·04 | ·24 | 5·3 | 35·8 | 2·05 | Grass, green, leafy. |
| | | June, 1935 | ·055 | ·19 | ·06 | ·29 | trace | ·12 | 2·7 | 40·2 | 1·60 | Grass, mainly brown, short. |
| | | Sept., 1935 | ·09 | ·27 | ·05 | ·63 | ·03 | ·09 | 4·5 | 36·6 | 1·75 | Grass, brown, leafy. |
| Nyokweni Location | Tabankulu..... | Feb., 1935 | ·05 | ·23 | ·10 | ·34 | ·02 | ·09 | 4·7 | 35·9 | 1·27 | Grass, leafy. |
| | | May, 1935 | ·074 | ·33 | ·11 | ·39 | ·03 | ·07 | 5·0 | 39·5 | 1·54 | Grass. |
| | | Aug., 1935 | ·044 | ·26 | ·11 | ·13 | ·01 | ·05 | 2·0 | 37·1 | 1·07 | Grass, brown, leafy. |

AREA 4 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Amanikwe Location | Bizana........ | Jan., 1935 | ·053 | ·18 | ·15 | ·33 | ·12 | ·17 | 4·1 | 32·9 | 1·66 | Grass, mainly green, leafy. |
| | | April, 1935 | ·06 | ·21 | ·12 | ·36 | ·04 | ·10 | 4·1 | 34·6 | 1·64 | Grass, leafy. |
| | | July, 1935 | ·056 | ·22 | ·08 | ·24 | ·06 | ·12 | 3·1 | 36·1 | 1·37 | Grass, mainly brown, leafy. |
| | | Oct., 1935 | ·062 | ·20 | ·08 | ·26 | ·10 | ·08 | 4·3 | 37·1 | 1·45 | Grass, mainly brown, leafy. |
| Izinini Location.. | Bizana........ | Feb., 1935 | ·07 | ·21 | ·13 | ·44 | ·16 | ·25 | 5·3 | 35·6 | 1·75 | Grass, green. |
| | | May, 1935 | ·14 | ·22 | ·16 | ·58 | ·10 | ·21 | 4·0 | 37·8 | 1·99 | Grass, mainly brown. |
| | | Sept., 1935 | ·035 | ·13 | ·05 | ·21 | ·04 | ·11 | 3·3 | 36·5 | 0·97 | Grass, brown. |
| Isekelo Location.. | Bizana........ | Mar., 1935 | ·13 | ·25 | ·14 | ·82 | ·09 | ·22 | 5·4 | 35·6 | 2·45 | Grass, mainly green. |
| | | June, 1935 | ·074 | ·25 | ·11 | ·43 | ·02 | ·46 | 3·8 | 39·1 | 2·83 | Grass, mainly brown, leafy. |
| | | Aug., 1935 | ·05 | ·25 | ·13 | ·22 | ·04 | ·08 | 2·9 | 37·0 | 1·70 | Grass, brown, leafy. |
| Ntshangasi Location | Flagstaff....... | Jan., 1934 | ·093 | ·20 | ·11 | ·89 | ·06 | ·20 | 7·4 | 34·9 | 2·33 | Grass, |
| | | April, 1934 | ·086 | ·24 | ·12 | ·81 | ·07 | ·09 | 6·6 | 35·7 | 2·07 | Grass. |
| | | Nov., 1934 | ·08 | ·18 | ·09 | ·87 | ·19 | ·25 | 7·1 | 34·0 | 2·19 | Grass. |
| | | Mar., 1935 | ·087 | ·20 | ·08 | ·77 | ·04 | ·19 | 5·8 | 37·4 | 1·79 | Grass, mainly green, leafy |
| | | July, 1935 | ·077 | ·20 | ·11 | ·42 | ·03 | ·17 | 3·6 | 37·8 | 1·44 | Grass, mainly brown, short. |
| | | Sept., 1935 | ·065 | ·27 | ·04 | ·42 | ·03 | ·30 | 5·5 | 36·3 | 1·56 | Grass, short. |
| | | Oct., 1935 | ·12 | ·36 | ·17 | 1·08 | ·12 | ·35 | 5·9 | 35·8 | 2·48 | Grass, green, leafy. |
| Qasa Location.... | Flagstaff....... | Feb., 1934 | — | ·26 | ·21 | ·89 | ·13 | — | 7·2 | 36·5 | 2·66 | Grass, mainly green. |
| | | May, 1934 | ·036 | ·21 | ·12 | ·29 | ·10 | ·17 | 4·2 | 37·0 | 1·48 | Grass, mainly brown, leafy. |
| | | April, 1935 | ·055 | ·23 | ·12 | ·29 | ·03 | ·07 | 4·2 | 35·8 | 1·40 | Grass, mainly green, leafy. |
| | | June, 1935 | ·065 | ·23 | ·10 | ·38 | ·02 | ·16 | 3·5 | 37·9 | 1·78 | Grass, leafy. |
| Ntlenzi Location.. | Flagstaff....... | Mar., 1934 | ·10 | ·22 | ·13 | ·99 | ·11 | ·24 | 7·3 | 38·1 | 2·35 | Grass. |
| | | Aug., 1934 | ·04 | ·18 | ·04 | ·12 | ·01 | ·02 | 2·7 | 37·0 | 1·13 | Grass, mainly brown, leafy. |
| | | May, 1935 | ·049 | ·23 | ·08 | ·35 | ·03 | ·09 | 4·2 | 34·6 | 1·88 | Grass, mainly brown, leafy. |
| Sipageni Location | Flagstaff....... | Nov., 1934 | ·092 | ·16 | ·09 | ·72 | ·06 | ·20 | 5·3 | 35·1 | 1·83 | Grass, mainly green. |
| | | April, 1935 | ·065 | ·27 | ·12 | ·68 | trace | ·06 | 4·8 | 34·7 | 1·85 | Grass, mainly green. |
| | | July, 1935 | ·05 | ·20 | ·06 | ·24 | ·03 | ·09 | 3·1 | 36·7 | 1·30 | Grass, mainly brown, leafy. |
| | | Oct., 1935 | ·092 | ·33 | ·14 | ·75 | ·11 | ·20 | 7·7 | 34·8 | 2·67 | Grass, mainly green, leafy. |
| Tekweni Location | Flagstaff....... | Feb., 1935 | ·15 | ·28 | ·19 | 1·92 | ·36 | ·18 | 6·3 | 38·6 | 4·36 | Grass, green, leafy. |
| | | May, 1935 | ·089 | ·32 | ·33 | ·48 | ·05 | ·16 | 5·2 | 38·4 | 2·09 | Grass, green, leafy. |
| | | June, 1935 | ·08 | ·32 | ·12 | ·22 | trace | ·09 | 2·6 | 37·5 | 1·45 | Grass. |
| | | Aug., 1935 | ·10 | ·18 | ·16 | ·68 | ·06 | ·21 | 3·9 | 38·3 | 1·68 | Grass, mainly brown. |
| Nkozo Location.. | Flagstaff....... | Mar., 1935 | ·056 | ·24 | ·14 | ·71 | ·02 | ·17 | 5·3 | 40·4 | 1·74 | Grass, green, long. |
| | | Sept., 1935 | ·072 | ·29 | ·13 | ·28 | ·13 | ·14 | 6·3 | 34·7 | 2·72 | Grass, leafy. |

## AREA 4 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Zalu Location.... | Lusikisiki...... | Nov., 1933 | ·19 | ·29 | ·16 | 1·68 | ·56 | ·78 | 11·2 | 37·6 | 4·85 | Grass. |
| | | Aug., 1934 | ·05 | ·23 | ·12 | ·27 | ·03 | ·06 | 4·0 | 37·1 | 1·32 | Grass, mainly brown. |
| | | Nov., 1934 | ·068 | ·26 | ·10 | ·36 | ·09 | ·22 | 4·2 | 35·4 | 1·78 | Grass, long. |
| | | Feb., 1935 | ·095 | ·35 | ·16 | ·96 | ·13 | ·67 | 7·0 | 34·1 | 2·57 | Grass, green, leafy and bush: mostly grass. |
| | | May, 1935 | ·13 | ·33 | ·18 | ·81 | ·51 | ·50 | 8·5 | 35·2 | 3·28 | Grass, green, leafy. |
| | | Aug., 1935 | ·065 | ·26 | ·11 | ·30 | ·28 | ·36 | 4·5 | 38·7 | 1·62 | Grass, mainly green. |
| Nyosana Location | Lusikisiki...... | May, 1934 | ·065 | ·35 | ·17 | ·54 | ·41 | ·76 | 5·0 | 35·9 | 2·75 | Grass, mainly green. |
| | | Aug., 1934 | ·056 | ·17 | ·09 | ·39 | ·04 | ·13 | 5·1 | 41·6 | 1·22 | Grass, mainly green. |
| | | Dec., 1934 | ·087 | ·18 | ·13 | 1·45 | ·26 | ·68 | 8·4 | 35·3 | 3·67 | Grass, mainly green. |
| | | Mar., 1935 | ·12 | ·45 | ·20 | ·60 | ·19 | ·26 | 7·3 | 36·3 | 2·68 | Grass, green, long and bush: mostly grass. |
| | | June, 1935 | ·07 | ·20 | ·17 | ·47 | ·19 | ·27 | 5·4 | 38·6 | 2·19 | Grass, mainly green. |
| | | Sept., 1935 | ·083 | ·22 | ·12 | ·64 | ·14 | ·38 | 5·8 | 32·6 | 1·97 | Grass, mainly green. |
| Zalu Heights Location | Lusikisiki...... | June, 1934 | ·17 | ·45 | ·27 | ·67 | ·76 | 1·15 | 7·6 | 34·6 | 4·56 | Grass, mainly green, leafy. |
| | | Sept., 1934 | ·10 | ·20 | ·15 | ·68 | ·55 | ·55 | 7·7 | 37·4 | 2·68 | Grass, mainly green. |
| | | Jan., 1935 | ·058 | ·18 | ·14 | ·61 | ·13 | ·32 | 5·1 | 34·8 | 1·70 | Grass, mainly green, long. |
| | | May, 1935 | ·065 | ·27 | ·16 | ·62 | ·15 | ·18 | 5·2 | 39·6 | 2·08 | Grass, mainly green, leafy. |
| | | July, 1935 | ·13 | ·73 | ·27 | ·45 | ·26 | ·29 | 7·4 | 34·5 | 3·31 | Grass, minaly green and bush. |
| | | Oct., 1935 | ·11 | ·22 | ·13 | ·73 | ·24 | ·37 | 7·0 | 36·9 | 2·28 | Grass, green, leafy. |
| Lusikisiki Commonage | Lusikisiki...... | Nov., 1933 | ·11 | ·25 | ·14 | 1·04 | ·14 | ·39 | 8·2 | 34·6 | 3·45 | Grass, mainly green, short. |
| | | May, 1934 | ·05 | ·31 | ·20 | ·49 | ·03 | ·21 | 4·4 | 33·3 | 2·08 | Grass, short. |
| | | April, 1935 | ·09 | ·23 | ·11 | ·41 | ·02 | ·07 | 4·5 | 30·2 | 1·85 | Grass, short. |
| | | July, 1935 | ·046 | ·19 | ·11 | ·28 | ·05 | ·11 | 2·8 | 36·9 | 1·60 | Grass, mainly brown, short. |
| | | Sept., 1935 | ·044 | ·17 | ·11 | ·27 | ·03 | ·10 | 3·2 | 36·1 | 1·55 | Grass, mainly brown, short. |
| Mzinthlava Location | Lusikisiki...... | June, 1934 | ·03 | ·19 | ·14 | ·29 | ·03 | ·10 | 2·9 | 34·4 | 1·55 | Grass, mainly brown, short. |
| | | Mar., 1935 | ·06 | ·19 | ·16 | ·46 | ·13 | ·30 | 4·4 | 41·3 | 1·76 | Grass, mainly green. |
| | | May, 1935 | ·11 | ·31 | ·18 | ·81 | ·19 | ·44 | 7·9 | 35·4 | 2·50 | Grass, green. |
| Lambasi Location | Lusikisiki...... | Jan., 1935 | ·076 | ·20 | ·17 | ·70 | ·05 | ·29 | 5·5 | 33·9 | 2·01 | Grass, green, short. |
| | | June, 1935 | ·052 | ·20 | ·10 | ·28 | trace | ·28 | 3·7 | 32·7 | 1·87 | Grass, mainly brown, short. |
| | | Aug., 1935 | ·047 | ·27 | ·11 | ·30 | ·03 | ·10 | 3·5 | 33·8 | 1·96 | Grass, short. |
| Ngquza Hill Location | Lusikisiki...... | Mar., 1934 | ·036 | ·21 | ·19 | ·75 | ·31 | ·39 | 6·6 | 38·8 | 2·64 | Grass, mainly green. |
| | | May, 1934 | ·043 | ·19 | ·17 | ·42 | ·11 | ·31 | 3·7 | 39·3 | 1·66 | Grass, long. |
| | | Sept., 1934 | ·063 | ·14 | ·12 | ·60 | ·14 | ·34 | 4·9 | 41·6 | 1·70 | Grass, long. |
| | | Nov., 1934 | ·078 | ·24 | ·14 | ·62 | ·25 | ·75 | 4·2 | 37·2 | 2·20 | Grass, long. |
| | | July, 1935 | ·095 | ·18 | ·15 | ·68 | ·14 | ·43 | 4·8 | 39·7 | 1·90 | Grass. |
| | | Nov., 1935 | ·057 | ·17 | ·15 | ·52 | ·26 | ·60 | 5·2 | 39·8 | 2·35 | Grass, mainly green. |
| Mhlumba Location | Lusikisiki...... | May, 1934 | ·12 | ·56 | ·26 | 1·18 | ·38 | ·73 | 8·7 | 37·8 | 4·18 | Grass, mainly green, leafy and bush: mostly grass. |
| | | Jan., 1935 | ·076 | ·18 | ·10 | ·96 | ·08 | ·37 | 4·7 | 37·7 | 2·17 | Grass, mainly green. |

### AREA 4 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kanywayo Location | Lusikisiki...... | April, 1934 | ·082 | ·25 | ·14 | ·77 | ·23 | ·44 | 5·2 | 34·8 | 2·23 | Grass. |
| | | July, 1934 | ·057 | ·19 | ·12 | ·52 | ·08 | ·25 | 3·5 | 39·8 | 1·73 | Grass, mainly brown, short. |
| | | Oct., 1934 | ·073 | ·17 | ·12 | ·62 | ·17 | ·70 | 5·1 | 36·9 | 2·03 | Grass, mainly green, long. |
| | | Sept., 1935 | ·08 | ·17 | ·10 | 1·13 | ·20 | ·89 | 5·9 | 40·0 | 3·14 | Grass, mainly green. |
| Views Farm No. 9 | Port St. Johns. | May, 1934 | ·077 | ·41 | ·19 | ·59 | ·30 | ·47 | 5·7 | 38·9 | 3·10 | Grass, mainly green. |
| | | Aug., 1934 | ·18 | ·31 | ·21 | 1·53 | ·18 | ·67 | 8·9 | 33·4 | 3·93 | Grass, mainly green. |
| | | Dec., 1934 | ·18 | ·30 | ·14 | 1·88 | ·38 | 1·00 | 11·1 | 35·8 | 4·48 | Grass, green. |
| | | April, 1935 | ·23 | ·32 | ·16 | 1·85 | ·41 | ·59 | 10·0 | 33·9 | 4·86 | Grass. |
| | | July, 1935 | ·22 | ·30 | ·23 | 2·59 | ·32 | 1·33 | 9·2 | 33·6 | 6·08 | Grass, mainly green. |
| | | Oct., 1935 | ·28 | ·31 | ·24 | 2·50 | ·43 | 1·58 | 10·7 | 36·7 | 6·83 | Grass, green, leafy. |
| Fairview......... | Port St. Johns. | June, 1934 | ·11 | ·25 | ·13 | ·49 | ·18 | ·34 | 3·7 | 36·9 | 2·01 | Grass, mainly brown. |
| | | Oct., 1934 | ·19 | ·23 | ·16 | ·87 | ·46 | ·54 | 6·5 | 32·3 | — | Grass, mainly green. |
| | | Nov., 1934 | ·17 | ·22 | ·14 | ·83 | ·29 | ·56 | 6·5 | 35·9 | 3·16 | Grass. |
| | | Mar., 1935 | ·12 | ·15 | ·08 | ·59 | ·10 | ·20 | 3·5 | 39·4 | 1·77 | Grass, mainly green, long. |
| | | May, 1935 | ·19 | ·57 | ·33 | 1·22 | ·26 | ·31 | 8·3 | 36·7 | 4·37 | Grass, mainly green and bush; mostly grass. |
| | | Aug., 1935 | ·11 | ·22 | ·20 | ·60 | ·20 | ·31 | 3·8 | 38·6 | 2·16 | Grass, mainly brown, leafy. |
| No. 11.......... | Port St. Johns. | Mar., 1935 | ·22 | ·32 | ·23 | 1·02 | ·34 | ·69 | 9·2 | 33·6 | 4·48 | Grass, green, leafy. |
| | | June, 1935 | ·11 | ·20 | ·16 | ·85 | ·10 | ·46 | 4·1 | 41·4 | 2·55 | Grass, mainly green, long. |
| | | Sept., 1935 | ·11 | ·25 | ·23 | ·81 | ·18 | ·37 | 5·6 | 38·7 | 2·58 | Grass, mainly brown. |
| Silverton......... | Umtata......... | Mar., 1934 | ·058 | ·27 | ·11 | ·73 | ·02 | ·22 | 4·9 | 35·2 | 2·06 | Grass, short. |
| | | June, 1934 | ·04 | ·28 | ·10 | ·33 | ·04 | ·11 | 3·2 | 35·8 | 1·62 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·042 | ·23 | ·07 | ·29 | ·03 | ·11 | 4·1 | 35·3 | 1·44 | Grass, mainly brown, leafy. |
| | | Dec., 1934 | ·083 | ·24 | ·09 | ·73 | ·03 | ·13 | 5·0 | 36·2 | 1·70 | Grass, leafy. |
| | | Mar., 1935 | ·052 | ·19 | ·09 | ·49 | ·01 | ·07 | 2·9 | 35·4 | 1·35 | Grass, mainly brown, leafy. |
| | | June, 1935 | ·052 | ·25 | ·09 | ·33 | ·02 | ·13 | 3·4 | 37·0 | 1·54 | Grass, mainly brown, leafy. |
| Waterfall........ | Umtata......... | April, 1934 | ·07 | ·21 | ·09 | ·68 | ·02 | ·17 | 4·9 | 33·5 | 1·94 | Grass, leafy. |
| | | July, 1934 | ·048 | ·27 | ·08 | ·31 | ·01 | ·07 | 2·4 | 34·1 | 1·47 | Grass, brown, leafy. |
| | | Oct., 1934 | ·073 | ·21 | ·10 | ·49 | trace | ·12 | 4·3 | 33·5 | 1·73 | Grass, mainly brown, short. |
| | | Jan., 1935 | ·06 | ·24 | ·08 | ·76 | ·02 | ·14 | 3·8 | 32·7 | 1·76 | Grass, short. |
| | | April, 1935 | ·085 | ·30 | ·10 | ·60 | trace | ·11 | 4·9 | 31·7 | 2·26 | Grass, mainly brown, short. |
| Glendon......... | Umtata......... | June, 1934 | ·056 | ·35 | ·11 | ·68 | ·01 | ·20 | 5·3 | 32·0 | 1·92 | Grass, mainly brown, leafy. |
| | | Aug., 1934 | ·047 | ·37 | — | ·26 | trace | ·07 | 5·1 | 36·8 | 1·53 | Grass, brown, leafy. |
| | | Nov., 1934 | ·056 | ·26 | ·09 | ·72 | ·04 | ·20 | 4·6 | 37·7 | 1·82 | Grass, leafy. |
| | | Feb., 1935 | ·055 | ·23 | ·09 | ·63 | ·04 | ·29 | 3·7 | 34·7 | 1·80 | Grass, leafy. |
| | | May, 1935 | ·078 | ·28 | ·09 | ·43 | ·02 | ·08 | 3·5 | 37·4 | 1·46 | Grass, leafy. |
| | | Aug., 1935 | ·059 | ·25 | ·08 | ·22 | ·03 | ·08 | 2·9 | 41·5 | 0·93 | Grass, brown, leafy. |

## AREA 5.

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Silver Streams... | Glen Grey..... | Dec., 1933 | ·13 | ·37 | ·15 | 1·22 | ·03 | ·24 | 10·4 | 33·2 | 3·30 | Grass, green, leafy. |
| | | Mar., 1934 | ·20 | ·31 | ·22 | 2·05 | ·04 | ·32 | 8·6 | 34·1 | 4·07 | Grass, mainly green. |
| | | June, 1934 | ·05 | ·38 | ·08 | ·42 | trace | ·09 | 3·9 | 33·0 | 1·68 | Grass, brown, leafy. |
| | | Sept., 1934 | ·045 | ·38 | ·11 | ·14 | trace | ·05 | 3·2 | 34·0 | 1·49 | Grass, brown, leafy. |
| | | Dec., 1934 | ·12 | ·28 | ·06 | ·89 | ·02 | ·18 | 6·6 | 33·6 | 1·93 | Grass, mainly green, leafy. |
| | | Mar., 1935 | ·092 | ·27 | ·06 | ·47 | trace | ·08 | 5·0 | 33·3 | 1·54 | Grass, leafy. |
| | | June, 1935 | ·11 | ·25 | ·09 | ·54 | trace | ·07 | 3·9 | 39·5 | 1·66 | Grass, mainly brown. |
| | | Sept., 1935 | ·086 | ·27 | ·05 | ·36 | ·01 | ·04 | 3·2 | 34·9 | 1·52 | Grass, brown, leafy. |
| Matyantya....... | Glen Grey..... | Jan., 1934 | ·24 | ·26 | ·16 | 2·29 | ·04 | ·42 | 13·0 | 32·3 | 4·55 | Grass, green, leafy. |
| | | April, 1934 | ·11 | ·23 | ·08 | ·85 | ·03 | ·19 | 5·4 | 36·4 | 1·87 | Grass, mainly green. |
| | | July, 1934 | ·08 | ·33 | ·09 | ·37 | ·01 | ·11 | 4·1 | 34·1 | 1·68 | Grass, brown, leafy. |
| | | Oct., 1934 | ·054 | ·35 | ·06 | ·12 | ·01 | ·01 | 3·3 | 35·3 | 1·08 | Grass, brown, short. |
| | | Jan., 1935 | ·074 | ·25 | ·05 | ·35 | ·03 | ·13 | 4·2 | 31·2 | 1·45 | Grass, leafy. |
| | | April. 1935 | ·15 | ·29 | ·09 | ·65 | ·01 | ·11 | 6·6 | 36·5 | 1·88 | Grass, mainly green. |
| | | July, 1935 | ·12 | ·25 | ·07 | ·33 | ·02 | ·08 | 3·0 | 36·1 | 1·30 | Grass, brown, leafy. |
| | | Oct., 1935 | ·11 | ·26 | ·08 | ·61 | ·01 | ·09 | 4·3 | 32·4 | 1·38 | Grass, brown, leafy. |
| Wolfham........ | Glen Grey..... | Feb., 1934 | ·23 | ·31 | ·21 | 2·60 | ·06 | ·47 | 11·2 | 34·1 | 5·40 | Grass, green. |
| | | May, 1934 | ·064 | ·28 | ·17 | ·66 | ·01 | ·17 | 4·9 | 35·7 | 1·80 | Grass, mainly green. |
| | | Aug., 1934 | ·042 | ·30 | ·08 | ·17 | trace | ·02 | 2·8 | 37·0 | 1·26 | Grass, mainly brown. |
| | | Nov., 1934 | ·058 | ·24 | ·06 | ·33 | trace | ·07 | 3·7 | 36·9 | 1·42 | Grass, brown, leafy. |
| | | Feb., 1935 | ·072 | ·27 | ·07 | ·72 | trace | ·15 | 3·8 | 35·2 | 1·81 | Grass, leafy. |
| | | May, 1935 | ·12 | ·28 | ·09 | ·69 | ·03 | ·09 | 6·3 | 35·6 | 1·95 | Grass, mainly green. |
| | | Aug., 1935 | ·076 | ·29 | ·09 | ·35 | ·01 | ·10 | 3·7 | 33·7 | 1·52 | Grass, brown, leafy. |
| Thornyvale...... | Queenstown.... | Nov., 1933 | ·20 | ·52 | ·24 | 2·57 | ·14 | ·55 | 9·0 | 29·4 | 5·07 | Grass, green & bush; mostly grass. |
| | | Feb., 1934 | ·16 | ·31 | ·20 | 2·12 | ·11 | ·46 | 7·5 | 34·4 | 4·33 | Grass, mainly green. |
| | | May, 1934 | ·19 | ·46 | ·32 | 2·53 | ·06 | ·74 | 9·1 | 34·4 | 5·62 | Grass, mainly green and bush; mostly grass. |
| | | Aug., 1934 | ·09 | ·45 | ·16 | ·84 | ·01 | ·18 | 5·5 | 40·7 | 2·44 | Grass, mainly brown and bush; mostly grass. |
| | | Nov., 1934 | ·08 | ·41 | ·12 | ·95 | ·03 | ·18 | 5·5 | 40·2 | 2·53 | Grass, mainly brown and bush. |
| | | Feb., 1935 | ·19 | ·34 | ·17 | 1·95 | ·04 | ·50 | 9·7 | 33·4 | 4·25 | Grass, green, leafy. |
| | | May. 1935 | ·14 | ·34 | ·17 | 1·49 | ·03 | ·35 | 7·5 | 34·3 | 3·32 | Grass, green, leafy. |
| | | Aug., 1935 | ·11 | ·42 | ·18 | ·90 | ·07 | ·24 | 6·1 | 39·8 | 2·58 | Grass, mainly brown. |
| Oakleigh........ | Queenstown.... | Dec., 1933 | ·16 | ·45 | ·25 | 2·01 | ·05 | ·49 | 9·0 | 32·4 | 4·63 | Grass, mainly green and bush; mostly grass. |
| | | Mar., 1934 | ·16 | ·26 | ·13 | 1·68 | ·06 | ·40 | 7·4 | 36·2 | 3·84 | Grass, mainly green. |
| | | June, 1934 | ·08 | ·19 | ·14 | ·94 | ·05 | ·33 | 4·0 | 34·3 | 2·35 | Grass, mainly brown, long. |
| | | Sept., 1934 | ·10 | ·29 | ·36 | ·93 | ·04 | ·29 | 5·5 | 38·4 | 2·25 | Grass, mainly brown, short and bush; mostly grass. |
| | | Dec., 1934 | ·16 | ·23 | ·15 | 1·62 | ·04 | ·56 | 8·4 | 34·0 | 3·72 | Grass, green, leafy. |
| | | Mar., 1935 | ·16 | ·28 | ·14 | 1·50 | ·08 | ·38 | 7·6 | 30·8 | 3·49 | Grass, green. |
| | | June, 1935 | ·15 | ·32 | ·15 | 1·14 | ·03 | ·27 | 5·1 | 38·2 | 3·04 | Grass. |
| | | Sept., 1935 | ·17 | ·34 | ·09 | 1·55 | ·10 | ·39 | 9·3 | 35·5 | 3·47 | Grass, mainly green, short. |

AREA 5 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Vlakfontein**...... | **Queenstown**.... | Jan., 1934 | ·17 | ·37 | ·38 | 2·29 | ·03 | ·43 | 9·6 | 34·8 | 8·34 | Grass, mainly green and bush. |
| | | April, 1934 | ·23 | ·52 | ·34 | 2·41 | ·07 | ·43 | 10·1 | 34·8 | 5·37 | Grass, mainly green and bush; mostly grass. |
| | | July, 1934 | ·11 | ·42 | ·14 | ·80 | ·03 | ·14 | 5·2 | 36·0 | 2·46 | Grass, mainly brown and bush; mostly grass. |
| | | Oct., 1934 | ·11 | ·30 | ·20 | 1·17 | ·04 | ·31 | 7·0 | 32·4 | 2·32 | Grass, mainly green and bush; mostly grass. |
| | | Jan., 1935 | ·15 | ·34 | ·18 | 1·47 | ·04 | ·53 | 8·4 | 36·9 | 3·42 | Grass, green, leafy. |
| | | April, 1935 | ·10 | ·53 | ·17 | 1·17 | ·10 | ·24 | 7·2 | 31·0 | 4·05 | Grass, green. |
| | | July, 1935 | ·15 | ·49 | ·20 | 1·03 | ·02 | ·21 | 6·9 | 35·0 | 2·93 | Grass, mainly brown and bush. |
| | | Oct., 1935 | ·13 | ·71 | ·19 | 1·36 | ·15 | ·33 | 8·4 | 32·3 | 4·17 | Grass, green, short and bush; mostly grass. |
| **Hopewell**........ | **Queenstown**.... | Dec., 1933 | ·35 | — | — | — | — | ·43 | 16·3 | 30·1 | — | Grass, green, short. |
| | | July, 1934 | ·13 | ·31 | ·10 | ·46 | ·01 | ·03 | 5·9 | 34·2 | 1·82 | Grass, brown. |
| | | April, 1935 | ·22 | ·47 | ·18 | 1·60 | ·04 | ·30 | 11·4 | 28·5 | 3·99 | Grass, green,short. |
| | | Aug., 1935 | ·09 | ·31 | ·13 | ·61 | ·02 | ·14 | 5·0 | 31·5 | 1·94 | Grass, brown, short. |
| **Quebequebe**...... | **Queenstown**.... | June, 1934 | ·17 | ·40 | ·10 | — | ·02 | ·18 | 5·0 | 39·2 | 2·19 | Grass, mainly brown. |
| | | Oct., 1934 | ·26 | ·46 | ·18 | 2·00 | ·05 | ·58 | 11·6 | 27·7 | 4·53 | Grass, mainly green, leafy. |
| | | June, 1935 | ·21 | ·27 | ·19 | 1·32 | ·15 | ·46 | 7·3 | 35·7 | 3·58 | Grass. |
| | | Sept., 1935 | ·19 | ·52 | ·14 | 1·56 | ·03 | ·41 | 10·6 | 31·5 | 3·71 | Grass, leafy. |
| **Ixworth**......... | **Queenstown**.... | Mar., 1934 | ·098 | ·38 | ·11 | 1·32 | ·01 | ·28 | 4·9 | 40·2 | 2·79 | Grass, mainly green. |
| | | Aug., 1934 | ·067 | ·22 | ·08 | ·32 | ·01 | ·02 | 4·2 | 36·3 | 1·33 | Grass, mainly brown. |
| | | Nov., 1934 | ·14 | ·33 | ·11 | 1·05 | ·02 | ·29 | 7·6 | 32·3 | 2·60 | Grass. |
| | | Feb., 1935 | ·11 | ·30 | ·12 | 1·21 | ·03 | ·32 | 6·1 | 36·6 | 2·67 | Grass, mainly green. |
| | | July, 1935 | ·075 | ·23 | ·07 | ·34 | ·01 | ·07 | 4·4 | 37·6 | 1·10 | Grass, brown. |
| | | Oct., 1935 | ·17 | ·46 | ·20 | ·98 | ·03 | ·20 | 8·6 | 30·0 | 2·46 | Grass, mainly green, short. |
| **Dunskeyi**....... | Cathcart..... | Nov., 1933 | ·12 | ·31 | ·08 | ·79 | ·02 | ·17 | 6·6 | 33·3 | 2·25 | Grass, mainly green, leafy. |
| | | Feb., 1934 | ·088 | ·40 | ·11 | ·76 | ·03 | ·20 | 5·9 | 31·8 | 2·55 | Grass, mainly green, short. |
| | | May, 1934 | ·077 | ·41 | ·15 | ·82 | ·02 | ·21 | 4·8 | 29·9 | 2·37 | Grass, leafy. |
| | | Aug., 1934 | ·045 | ·33 | ·09 | ·26 | ·01 | ·08 | 4·0 | 31·2 | 1·48 | Grass, mainly brown, leafy. |
| | | Dec., 1934 | ·085 | ·39 | ·08 | ·92 | ·03 | ·15 | 6·0 | 30·7 | 2·23 | Grass, green, leafy. |
| | | Mar., 1935 | ·13 | ·45 | ·09 | ·94 | ·03 | ·14 | 5·7 | 29·6 | 2·38 | Grass, green, short. |
| | | June, 1935 | ·054 | ·33 | ·09 | ·30 | ·02 | ·10 | 3·4 | 33·1 | 1·60 | Grass. mainly brown, leafy. |
| | | Sept., 1935 | ·078 | ·35 | ·07 | ·38 | ·02 | ·09 | 4·1 | 33·1 | 1·63 | Grass, short. |
| **Ailsa**........... | Cathcart....... | Dec., 1933 | ·16 | ·29 | ·12 | 1·33 | ·02 | ·33 | 9·4 | 33·3 | 2·87 | Grass, mainly green, short. |
| | | Mar., 1934 | ·095 | ·37 | ·13 | ·85 | ·01 | ·22 | 7·1 | 27·5 | 2·47 | Grass, short. |
| | | June, 1934 | ·092 | ·31 | ·08 | ·45 | ·01 | ·15 | 4·2 | 31·8 | 1·68 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·06 | ·32 | ·07 | ·36 | ·01 | ·08 | 6·0 | 32·4 | 1·74 | Grass, mainly brown, leafy. |
| | | Jan., 1935 | ·07 | ·39 | ·09 | ·75 | ·02 | ·25 | 5·7 | 30·8 | 2·08 | Grass, green, short. |
| | | April, 1935 | ·08 | ·35 | ·11 | ·51 | ·03 | ·10 | 6·0 | 30·7 | 3·39 | Grass, green, short. |
| | | July, 1935 | ·072 | ·39 | ·11 | ·27 | ·03 | ·08 | 2·8 | 32·6 | 1·53 | Grass, mainly brown, leafy. |
| | | Oct., 1935 | ·12 | ·36 | ·14 | 1·32 | ·02 | ·27 | 9·3 | 28·8 | 2·81 | Grass, green, short. |

## AREA 5 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **The Plains**....... | Cathcart....... | Jan., 1934 | ·13 | ·29 | ·09 | 1·23 | ·03 | ·14 | 7·6 | 35·1 | 3·03 | Grass, mainly green. |
| | | April, 1934 | ·08 | ·37 | ·10 | ·58 | ·02 | ·13 | 5·6 | 34·9 | 1·89 | Grass. |
| | | July, 1934 | ·064 | ·35 | ·11 | ·33 | ·03 | ·23 | 3·3 | 36·0 | 1·78 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·078 | ·33 | ·08 | ·46 | ·03 | ·15 | 4·5 | 32·5 | 1·54 | Grass, leafy. |
| | | Feb., 1935 | ·12 | ·45 | ·12 | 1·15 | ·04 | ·22 | 7·6 | 30·4 | 2·78 | Grass, green, short. |
| | | May, 1935 | ·086 | ·44 | ·09 | ·62 | ·02 | ·16 | 4·6 | 30·6 | 2·07 | Grass, mainly green, short. |
| | | Aug., 1935 | ·088 | ·33 | ·08 | ·48 | ·03 | ·11 | 3·6 | 38·7 | 1·72 | Grass, mainly brown, leafy. |
| **Alexandria**....... | Sterkstroom.... | Nov., 1933 | ·30 | ·54 | ·16 | 2·61 | ·06 | ·56 | 18·7 | 25·5 | 6·18 | Grass, green, short. |
| | | Aug., 1934 | ·21 | ·44 | ·12 | ·33 | trace | ·02 | 5·1 | 35·3 | 2·02 | Grass, brown, leafy. |
| | | Nov., 1934 | ·13 | ·47 | ·07 | ·71 | trace | ·08 | 5·1 | 31·8 | 2·39 | Grass, leafy. |
| | | April, 1935 | ·10 | ·33 | ·12 | ·78 | ·04 | ·16 | 6·6 | 32·3 | 2·23 | Grass, green, leafy. |
| | | July, 1935 | ·068 | ·33 | ·11 | ·24 | trace | ·07 | 3·5 | 39·7 | 1·50 | Grass, brown, leafy. |
| | | Oct., 1935 | ·093 | ·33 | ·09 | ·68 | trace | ·09 | 5·5 | 34·6 | 2·00 | Grass, mainly green, leafy. |
| **Blenheim**........ | Sterkstroom.... | Dec., 1933 | ·31 | ·51 | ·24 | 2·76 | ·07 | ·74 | 19·1 | 24·9 | 7·45 | Grass, green. |
| | | April, 1934 | ·20 | ·57 | ·22 | 1·24 | ·04 | ·35 | 8·2 | 30·9 | 3·99 | Grass, leafy. |
| | | June, 1934 | ·26 | ·58 | ·14 | ·49 | ·03 | ·07 | 4·5 | 32·1 | 2·65 | Grass, brown, leafy. |
| | | Sept., 1934 | ·12 | ·28 | ·18 | ·46 | ·01 | ·11 | 4·6 | 38·0 | 1·96 | Grass, mainly brown, leafy. |
| | | Dec., 1934 | ·24 | ·35 | ·13 | 1·67 | ·05 | ·20 | 7·8 | 31·8 | 3·37 | Grass, green, leafy. |
| | | Mar., 1935 | ·20 | ·46 | ·12 | ·93 | ·05 | ·16 | 6·0 | 27·3 | 2·83 | — |
| | | June, 1935 | ·19 | ·44 | ·15 | ·75 | ·02 | ·12 | 4·4 | 32·9 | 2·62 | Grass, brown, short. |
| | | Sept., 1935 | ·07 | ·24 | ·05 | ·37 | ·01 | ·09 | 5·5 | 31·7 | 1·48 | Grass, brown, leafy. |
| **Bell View**........ | Sterkstroom.... | April, 1934 | — | ·21 | ·16 | ·88 | ·03 | — | 3·7 | 30·0 | 2·11 | Grass, leafy. |
| | | July, 1934 | ·12 | ·30 | ·09 | ·30 | ·01 | ·03 | 2·7 | 35·6 | 1·56 | Grass, brown, leafy. |
| | | Oct., 1934 | ·18 | ·37 | ·10 | ·58 | ·03 | ·35 | 5·8 | 34·3 | 2·10 | Grass, mainly brown, leafy. |
| | | Jan., 1935 | ·20 | ·37 | ·12 | 1·06 | ·19 | ·29 | 6·4 | 35·2 | 2·99 | Grass, mainly green, leafy. |
| **Riverina**......... | Stutterheim.... | Nov., 1933 | ·15 | ·34 | ·11 | 1·41 | ·07 | ·31 | 9·9 | 32·2 | 3·39 | Grass, mainly green. |
| | | Feb., 1934 | ·15 | ·28 | ·12 | 1·50 | ·08 | ·35 | 8·7 | 31·9 | 3·36 | Grass, mainly green, short. |
| | | May., 1934 | ·11 | ·31 | ·10 | 1·18 | ·08 | ·34 | 7·8 | 33·0 | 3·00 | Grass, mainly green, short. |
| | | Aug., 1934 | ·06 | ·26 | ·09 | ·33 | ·01 | ·07 | 4·5 | 34·1 | 1·41 | Grass, brown, leafy. |
| | | Nov., 1934 | ·10 | ·30 | ·12 | 1·37 | ·05 | ·38 | 8·2 | 33·8 | 3·10 | Grass, mainly green, leafy. |
| | | Feb., 1935 | ·10 | ·28 | ·09 | ·86 | ·09 | ·25 | 5·7 | 30·6 | 2·25 | Grass, mainly green, leafy. |
| | | May, 1935 | ·14 | ·39 | ·12 | ·95 | ·11 | ·19 | 7·3 | 33·9 | 2·48 | Grass, mainly green, short. |
| | | Aug., 1935 | ·06 | ·31 | ·12 | ·25 | ·05 | ·09 | 3·1 | 36·1 | 1·69 | Grass, brown, leafy. |
| **Clevedon**......... | Stutterheim.... | Dec., 1933 | ·11 | ·30 | ·12 | 1·20 | ·05 | ·18 | 8·1 | 36·3 | 2·87 | Grass, mainly green. |
| | | Mar., 1934 | ·09 | ·24 | ·10 | ·92 | ·04 | ·17 | 6·8 | 35·1 | 2·23 | Grass, mainly green, leafy. |
| | | June, 1934 | ·05 | — | ·08 | ·36 | ·01 | ·08 | 5·1 | 32·9 | 1·58 | Grass, mainly brown, short. |
| | | Sept., 1934 | ·058 | ·34 | ·10 | ·36 | ·03 | ·11 | 4·6 | 32·0 | 1·64 | Grass, mainly brown, leafy. |
| | | Dec., 1934 | ·11 | ·39 | ·10 | 1·16 | ·11 | ·21 | 8·1 | 33·3 | 2·82 | Grass, mainly green, leafy. |
| | | Mar., 1935 | ·08 | ·34 | ·11 | ·78 | ·02 | ·17 | 5·3 | 35·8 | 2·06 | Grass, mainly green, leafy. |
| | | July, 1935 | ·044 | ·33 | ·09 | ·28 | ·02 | ·11 | 3·4 | 32·3 | 2·03 | Grass, mainly brown, leafy. |
| | | Sept., 1935 | ·053 | ·29 | ·08 | ·30 | ·02 | ·12 | 3·8 | 33·6 | 1·55 | Grass, leafy. |

## AREA 5 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Champagne...... | Stutterheim.... | Jan., 1934 | ·15 | ·25 | ·11 | 1·38 | ·21 | ·38 | 8·3 | 34·9 | 3·44 | Grass, mainly green. |
| | | April, 1934 | ·074 | ·46 | ·11 | ·72 | ·04 | 22 | 6·5 | 35·3 | 2·68 | Grass, leafy. |
| | | July. 1934 | ·052 | ·19 | ·09 | 31 | 01 | ·08 | 4·4 | 38·0 | 1·58 | Grass, mainly brown, short. |
| | | Oct., 1934 | ·07 | ·24 | ·09 | ·41 | ·05 | ·13 | 5·0 | 31·3 | 1·52 | Grass, mainly brown, leafy. |
| | | Jan., 1935 | ·13 | ·26 | ·11 | ·94 | ·18 | 28 | 6·7 | 30·6 | 2·69 | Grass, green, short. |
| | | April, 1935 | ·088 | ·34 | ·11 | ·80 | ·08 | ·12 | 5·5 | 32·7 | 2·07 | Grass, mainly green, leafy. |
| | | June, 1935 | ·06 | ·25 | ·08 | ·42 | ·02 | ·10 | 4·0 | 37·3 | 1·54 | Grass, mainly brown, short. |
| | | Oct., 1935 | ·095 | ·29 | ·09 | ·72 | ·06 | ·12 | 6·7 | 35·1 | 2·27 | Grass, green, leafy. |
| Redlands........ | Stutterheim.... | Dec., 1933 | ·26 | ·79 | ·30 | 3·54 | ·23 | ·82 | 16·3 | 23·6 | 8·42 | Grass, mainly green. |
| | | Feb., 1934 | ·10 | — | — | — | — | ·26 | — | 32·8 | — | Grass, mainly green, short. |
| | | May, 1934 | ·065 | ·24 | ·09 | ·46 | ·02 | ·09 | 4·8 | 36·7 | 2·04 | Grass, mainly brown, leafy. |
| | | Aug., 1934 | ·15 | 30 | ·15 | ·84 | ·11 | ·23 | 5·4 | 34·7 | 2·60 | Grass, mainly brown, short. |
| | | Nov., 1934 | ·18 | ·17 | ·11 | 1·73 | ·26 | ·73 | 10·4 | 31·5 | 3·87 | Grass, mainly green, short. |
| | | Feb., 1935 | ·092 | ·26 | ·09 | ·84 | ·06 | ·07 | 5·9 | 28·9 | 2·88 | Grass, mainly green, short. |
| | | May, 1935 | ·10 | ·26 | ·10 | ·51 | ·04 | ·12 | 5·5 | 34·5 | 1·91 | Grass, leafy. |
| | | Aug., 1935 | ·047 | ·37 | ·11 | ·30 | ·01 | ·05 | 3·6 | 39·7 | 1·88 | Grass, mainly brown. leafy. |
| Hazeldene....... | Stutterheim.... | Dec., 1933 | — | ·26 | ·12 | 1·92 | ·18 | — | 8·1 | 33·6 | 4·07 | Grass. |
| | | April, 1934 | ·09 | ·21 | ·09 | ·61 | ·03 | ·18 | 5·2 | 33·9 | 2·00 | Grass, short. |
| | | June, 1934 | ·09 | ·31 | ·10 | ·82 | ·04 | ·29 | 6·6 | 33·2 | 2·38 | Grass, mainly brown, short and bush : mostly grass. |
| | | Sept., 1934 | ·13 | ·22 | ·16 | 1·35 | ·28 | ·76 | 8·3 | 31·4 | 2·90 | Grass, short. |
| | | Dec., 1934 | ·11 | ·28 | ·10 | 1·62 | ·15 | ·65 | 10·2 | 33·9 | 3·73 | Grass, mainly green, short. |
| | | Mar., 1935 | ·15 | ·22 | ·10 | 1·10 | ·11 | 29 | 7·1 | 31·9 | 2·74 | Grass, green, leafy. |
| | | June, 1935 | ·062 | ·30 | ·08 | ·31 | trace | ·09 | 4·0 | 32·8 | 1·56 | Grass, mainly green, leafy. |
| | | Sept., 1935 | ·07 | ·25 | ·09 | ·61 | ·09 | ·34 | 5·0 | 31·8 | 2·05 | Grass, green, short. |
| Wetherrun....... | Stutterheim.... | Jan., 1934 | ·10 | ·71 | ·26 | 1·16 | ·06 | ·26 | 4·9 | 35·9 | 2·90 | Grass, short. |
| | | Mar., 1934 | ·07 | ·26 | ·10 | ·71 | ·02 | ·15 | 5·1 | 32·3 | 2·01 | Grass, short. |
| | | July, 1934 | ·05 | ·23 | ·10 | ·36 | ·01 | ·10 | 4·0 | 35·1 | 1·81 | Grass, mainly brown, short. |
| | | Oct., 1934 | ·15 | ·19 | ·14 | 1·16 | ·14 | ·39 | 8·8 | — | 2·86 | Grass, short. |
| | | Jan., 1935 | ·068 | ·26 | ·10 | ·91 | ·03 | ·27 | 5·3 | 34·0 | 2·41 | Grass, mainly green, short. |
| | | April, 1935 | ·20 | ·26 | ·11 | 1·53 | ·19 | ·38 | 8·2 | 30·6 | 3·63 | Grass, mainly green, leafy. |
| | | July, 1935 | 063 | ·25 | ·08 | ·46 | ·02 | ·15 | 4·3 | 35·5 | 1·59 | Grass, mainly brown, short. |
| | | Oct., 1935 | ·14 | ·21 | ·10 | ·84 | ·13 | ·23 | 6·7 | 33·3 | 2·50 | Grass. leafy. |
| Kei Slopes....... | Komgha....... | Nov., 1933 | ·052 | ·24 | ·19 | — | ·21 | ·20 | 3·1 | 43·7 | 1·63 | Grass, mainly brown, short. |
| | | June, 1934 | ·034 | ·23 | ·09 | ·31 | ·04 | ·12 | 3·1 | 37·8 | 1·35 | Grass, mainly brown. |
| | | Aug., 1934 | ·10 | ·23 | — | ·51 | ·06 | ·07 | 5·7 | 36·4 | 1·81 | Grass. |
| | | April, 1935 | ·058 | ·26 | ·09 | ·33 | ·05 | ·08 | 4·4 | 33·7 | 1·72 | Grass, leafy. |
| Kinderton....... | Komgha....... | Mar., 1934 | ·10 | ·38 | ·10 | ·90 | ·12 | ·24 | 5·8 | 40·9 | 2·30 | Grass, long. |
| | | July, 1934 | ·063 | ·29 | ·10 | ·52 | ·08 | ·22 | 4·4 | 37·6 | 1·86 | Grass, mainly brown. |
| | | Nov., 1934 | ·25 | ·27 | ·09 | 1·93 | ·17 | ·37 | 11·7 | 36·0 | 4·14 | Grass, leafy. |
| | | June, 1935 | ·036 | ·33 | ·09 | ·28 | ·03 | ·13 | 3·5 | 38·2 | 1·68 | Grass, mainly brown. |

### AREA 5 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Onverwacht...... | Komgha....... | April, 1934 | ·083 | ·27 | ·10 | ·90 | ·04 | ·14 | 5·6 | 35·8 | 1·92 | Grass, |
| | | Aug., 1934 | ·052 | ·21 | ·08 | ·24 | ·07 | ·14 | 4·0 | 39·6 | 1·21 | Grass, mainly brown. |
| | | Nov., 1934 | ·08 | ·23 | ·08 | ·52 | ·02 | ·15 | 5·7 | 32·9 | 1·72 | Grass, mainly green, leafy. |
| | | Feb., 1935 | ·09 | ·27 | ·06 | ·94 | ·11 | ·29 | 5·0 | 35·8 | 2·83 | Grass, green. |
| | | May, 1935 | ·082 | ·28 | ·07 | ·81 | ·07 | ·24 | 5·9 | 29·3 | 2·05 | Grass, mainly green. |
| Austin No. 250... | Komgha....... | Nov., 1933 | ·11 | ·63 | ·22 | 1·07 | ·20 | ·42 | 9·8 | 27·8 | 3·86 | Grass and bush; mostly grass. |
| | | Feb., 1934 | ·16 | ·80 | ·24 | 1·79 | ·09 | ·46 | 10·6 | 31·9 | 5·28 | Grass, mainly green and bush; mostly grass. |
| | | May, 1934 | ·086 | ·26 | ·11 | ·81 | ·18 | ·33 | 6·9 | 34·8 | 2·39 | Grass, leafy. |
| | | July, 1935 | ·11 | ·53 | ·20 | ·59 | ·13 | ·30 | 7·8 | 33·1 | 2·60 | Grass and bush; mostly grass. |
| | | Oct., 1935 | ·078 | ·44 | ·22 | ·62 | ·06 | ·21 | 7·3 | 34·0 | 2·79 | Grass, mainly green and bush; mostly grass. |
| Glenkei.......... | Komgha....... | Dec., 1933 | ·22 | ·39 | ·14 | 1·76 | ·30 | ·31 | 11·6 | 32·4 | 4·52 | Grass, mainly green. |
| | | Mar., 1934 | ·11 | 1·19 | ·26 | ·98 | ·12 | ·33 | 8·1 | 32·3 | 4·85 | Grass, green and bush. |
| | | June, 1934 | ·072 | ·32 | ·11 | ·52 | ·13 | ·18 | 6·4 | 35·1 | 2·02 | Grass, mainly green. |
| | | Aug., 1934 | ·16 | ·61 | ·17 | ·84 | ·13 | ·21 | 9·9 | 28·2 | 3·51 | Grass, short and bush; mostly grass. |
| | | Nov., 1934 | ·13 | ·50 | ·17 | 1·12 | ·19 | ·33 | 10·4 | 34·7 | 3·29 | Grass, green, leafy and bush; mostly grass. |
| | | Jan., 1935 | ·068 | ·41 | ·12 | ·90 | ·11 | ·33 | 6·3 | 33·2 | 2·58 | Grass, green, leafy. |
| | | Mar., 1935 | ·11 | ·44 | ·20 | 1·02 | ·25 | ·34 | 8·4 | 32·6 | 3·64 | Grass and bush; mostly grass. |
| | | June, 1935 | ·16 | ·88 | ·25 | 1·21 | ·09 | ·27 | 11·5 | 29·1 | 4·54 | Grass, green, leafy and bush; mostly grass. |
| | | Sept., 1935 | ·11 | 1·09 | ·28 | ·92 | ·07 | ·45 | 9·2 | 30·7 | 4·85 | Grass, leafy and bush. |
| Belladonna....... | Komgha....... | Jan., 1934 | ·10 | ·39 | ·11 | ·90 | ·21 | ·34 | 7·2 | 33·5 | 2·77 | Grass, mainly green. |
| | | April, 1934 | ·14 | ·44 | ·18 | 1·23 | ·17 | ·32 | 9·5 | 31·7 | 3·26 | Grass, mainly green and bush; mostly grass. |
| | | July, 1934 | ·055 | ·69 | ·19 | ·51 | ·05 | ·21 | 3·5 | 27·9 | 2·83 | Grass, mainly brown and bush; mostly grass. |
| | | Oct., 1934 | ·12 | ·61 | ·23 | ·72 | ·15 | ·19 | 9·0 | 25·5 | 2·99 | Grass, short and bush; mostly grass. |
| | | Dec., 1934 | ·10 | ·45 | ·14 | ·95 | ·18 | ·35 | 8·1 | 30·5 | 3·06 | Grass, green, leafy and bush; mostly grass. |
| | | Feb., 1935 | ·078 | ·75 | ·25 | 1·35 | ·15 | ·45 | 6·7 | 31·2 | 4·27 | Grass, mainly green, leafy and bush; mostly grass. |
| | | April, 1935 | ·092 | ·46 | ·16 | 1·03 | ·13 | ·26 | 6·6 | 34·3 | 2·94 | Grass, leafy. |
| | | May, 1935 | ·13 | ·82 | ·20 | 1·10 | ·17 | ·28 | 10·3 | 38·6 | 3·94 | Grass, leafy and bush; mostly grass. |
| | | Aug., 1935 | ·14 | ·49 | ·25 | ·39 | ·20 | ·21 | 7·0 | 30·7 | 2·73 | Grass, mainly green, leafy and bush; mostly grass. |

AREA 5 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Castledondale.... | Komgha....... | Nov., 1933 | ·11 | ·19 | ·09 | ·90 | ·14 | ·22 | 7·4 | 37·9 | 2·28 | Grass. |
| | | June, 1934 | ·042 | ·38 | ·09 | ·36 | ·03 | ·09 | 3·1 | 37·1 | 1·69 | Grass. |
| | | Mar., 1935 | ·064 | ·25 | ·09 | ·52 | ·04 | ·15 | 4·3 | 37·2 | 1·81 | Grass, leafy. |
| Gonubie Park.... | East London... | Nov., 1933 | ·12 | ·32 | ·13 | 1·34 | ·25 | ·38 | 9·5 | 36·9 | 3·63 | Grass,,and bush ; mostly grass |
| | | Feb., 1934 | ·20 | ·41 | ·19 | 2·09 | ·40 | 1·04 | 14·3 | 34·0 | 5·79 | Grass, mainly green, short. |
| | | May, 1934 | ·085 | ·19 | ·13 | 1·05 | ·13 | ·46 | 4·7 | 36·6 | 2·54 | Grass, leafy. |
| | | Aug., 1934 | ·10 | ·28 | ·17 | ·77 | ·18 | ·28 | 6·4 | 37·5 | 2·94 | Grass, short. |
| | | Nov., 1934 | ·086 | ·20 | ·18 | ·88 | ·19 | ·49 | 5·4 | 36·0 | 2·67 | Grass, mainly green, leafy. |
| | | Feb., 1935 | ·06 | ·16 | ·09 | ·52 | ·14 | ·06 | 3·2 | 34·3 | 2·03 | Grass, short. |
| | | May, 1935 | ·10 | ·33 | ·15 | ·89 | ·38 | ·28 | 7·5 | 37·5 | 3·40 | Grass, mainly green, leafy. |
| | | Aug., 1935 | ·13 | ·24 | ·16 | ·54 | ·20 | ·31 | 5·2 | 37·5 | 2·41 | Grass, leafy. |
| Rocklands....... | East London... | Dec., 1933 | ·12 | ·29 | ·15 | 1·40 | ·21 | ·44 | 8·8 | 33·2 | 3·84 | Grass, mainly green, short. |
| | | Mar., 1934 | ·24 | ·35 | ·13 | 1·54 | ·35 | ·68 | 10·8 | 32·5 | 4·26 | Grass, mainly green. |
| | | June, 1934 | ·085 | ·27 | ·14 | ·76 | ·43 | ·74 | 6·4 | 31·0 | 3·67 | Grass, short. |
| | | Sept., 1934 | ·10 | ·28 | ·11 | 1·05 | ·72 | ·96 | 9·9 | 32·0 | 3·92 | Grass, mainly green, short. |
| | | Jan., 1935 | ·12 | ·24 | ·16 | 1·13 | ·13 | ·41 | 6·5 | 34·3 | 2·90 | Grass, mainly green, leafy. |
| | | Mar., 1935 | ·075 | ·19 | ·13 | ·44 | ·17 | ·40 | 4·7 | 37·3 | 2·13 | Grass, mainly green short. |
| | | June, 1935 | ·16 | ·16 | ·10 | ·62 | ·12 | ·40 | 7·6 | 32·3 | 2·69 | Grass, mainly green, short. |
| | | Sept., 1935 | ·10 | ·20 | ·06 | ·83 | ·17 | ·41 | 6·9 | 38·7 | 2·52 | Grass, mainly green, leafy. |
| The Waterfall.... | East London... | Jan., 1934 | ·10 | ·56 | ·20 | 1·45 | ·39 | ·65 | 9·4 | 32·0 | 4·37 | Grass, mainly green and bush ; mostly grass. |
| | | April, 1934 | ·16 | ·27 | ·14 | 1·30 | ·22 | ·50 | 8·0 | 37·4 | 3·50 | Grass, mainly green, leafy. |
| | | July, 1934 | ·075 | ·20 | ·11 | ·68 | ·15 | ·45 | 7·1 | 38·0 | 2·17 | Grass, leafy. |
| | | Oct., 1934 | ·062 | ·25 | ·12 | ·65 | ·10 | ·25 | 5·3 | 33·8 | 2·05 | Grass, mainly green, leafy. |
| | | Jan., 1935 | ·085 | ·19 | ·11 | 1·02 | ·14 | ·45 | 5·4 | 36·3 | 2·59 | Grass, short. |
| | | April, 1935 | ·066 | ·24 | ·11 | ·58 | ·09 | ·28 | 4·8 | 34·2 | 1·93 | Grass, leafy. |
| | | July, 1935 | ·07 | ·23 | ·11 | ·44 | ·06 | ·20 | 4·1 | 38·4 | 1·75 | Grass, leafy. |
| | | Oct., 1935 | ·074 | ·18 | ·13 | ·59 | ·16 | ·39 | 5·1 | 38·7 | 2·55 | Grass, mainly green, leafy. |
| Foray Farm..... | Butterworth.... | May, 1934 | ·086 | ·29 | ·14 | ·56 | ·08 | ·23 | 4·6 | 36·9 | 1·91 | Grass. |
| | | Aug., 1934 | ·06 | ·28 | ·15 | ·14 | ·14 | ·11 | 3·2 | 39·0 | 1·48 | Grass, mainly brown. |
| | | Nov., 1934 | ·08 | ·27 | ·10 | ·37 | ·05 | ·09 | 4·3 | 38·0 | 1·76 | Grass, mainly brown. |
| | | Feb., 1935 | ·12 | ·25 | ·15 | ·89 | ·15 | ·43 | 6·4 | 33·1 | 2·50 | Grass, mainly green. |
| | | May, 1935 | ·11 | ·33 | ·13 | ·38 | ·04 | ·06 | 3·7 | 36·0 | 1·70 | Grass. |
| | | Aug., 1935 | ·08 | ·24 | ·15 | ·26 | ·25 | ·27 | 3·4 | 36·0 | 2·00 | Grass, mainly brown. |
| | | Oct., 1935 | ·06 | ·27 | ·14 | ·29 | ·03 | ·03 | 2·9 | 40·5 | 1·66 | Grass, brown. |
| Mhlambe........ | Butterworth.... | Feb., 1934 | ·11 | ·24 | ·08 | ·85 | ·15 | ·43 | 7·6 | 43·2 | 2·96 | Grass, mainly green. |
| | | June, 1934 | ·07 | ·26 | ·08 | ·62 | ·28 | ·52 | 5·5 | 39·3 | 2·53 | Grass. |
| | | Dec., 1934 | ·17 | ·28 | ·10 | 1·48 | ·12 | ·46 | 10·8 | 33·9 | 3·26 | Grass, green. |
| | | Mar., 1935 | ·032 | ·28 | ·09 | ·24 | ·02 | ·05 | 2·7 | 35·9 | 1·31 | Grass, long. |
| | | June, 1935 | ·12 | ·37 | ·15 | 1·11 | ·07 | ·27 | 6·5 | 32·7 | 2·79 | Grass, mainly green. |
| | | Sept., 1935 | ·035 | ·19 | ·06 | ·13 | ·03 | ·09 | 2·4 | 40·0 | 1·05 | Grass, brown. |

## AREA 5 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Fortune**......... | Butterworth.... | April, 1934 | ·086 | ·22 | ·11 | ·91 | ·08 | ·37 | 5·5 | 39·6 | 2·36 | Grass, mainly green. |
| | | July, 1934 | ·07 | ·25 | ·09 | ·31 | ·15 | ·27 | 3·2 | 37·4 | 1·66 | Grass, mainly brown. |
| | | Oct., 1934 | ·058 | ·20 | ·05 | ·22 | ·04 | ·06 | 3·8 | 35·9 | 1·40 | Grass. |
| | | Jan., 1935 | ·11 | ·23 | ·12 | ·96 | ·07 | ·34 | 6·4 | 36·3 | 2·22 | Grass, mainly green. |
| | | April, 1935 | ·11 | ·23 | ·10 | ·60 | ·24 | ·39 | 4·5 | 34·8 | 2·10 | Grass, mainly green. |
| | | July, 1935 | ·12 | ·32 | ·12 | ·49 | ·06 | ·18 | 4·4 | 34·2 | 2·04 | Grass, leafy. |
| **Reed Valley**..... | Alexandria..... | Nov., 1933 | ·12 | ·32 | ·10 | ·71 | ·20 | ·18 | 5·4 | 32·9 | 2·43 | Grass, mainly brown. |
| | | Feb., 1934 | ·14 | ·30 | ·10 | ·67 | ·11 | ·23 | 6·2 | 32·5 | 2·19 | Grass, short. |
| | | May, 1934 | ·10 | ·18 | ·07 | ·62 | ·12 | ·73 | 4·4 | 34·6 | 1·84 | Grass, mainly brown, short. |
| | | Aug., 1934 | ·16 | ·29 | — | ·65 | ·08 | ·20 | 6·9 | 33·5 | 2·23 | Grass, short. |
| | | Nov., 1934 | ·16 | ·48 | ·12 | 1·46 | ·17 | ·44 | 8·7 | 32·2 | 3·86 | Grass, mainly green. |
| | | Feb., 1935 | ·08 | ·26 | ·06 | ·39 | ·07 | ·11 | 4·4 | 34·8 | 1·77 | Grass, mainly brown. |
| | | May, 1935 | ·074 | ·33 | ·10 | ·45 | ·15 | ·18 | 5·4 | 34·6 | 2·28 | Grass, short and bush; mostly grass. |
| | | Aug., 1935 | ·14 | ·34 | ·12 | 1·08 | ·59 | ·55 | 8·6 | 34·7 | 3·56 | Grass, mainly green, short. |
| **Thorn Valley**..... | Alexandria..... | Dec., 1933 | ·066 | ·18 | ·07 | ·62 | ·12 | ·15 | 3·7 | 36·2 | 1·97 | Grass, mainly brown, short. |
| | | Mar., 1934 | ·066 | ·22 | ·07 | ·89 | ·11 | ·22 | 5·5 | 36·5 | 2·42 | Grass, short. |
| | | June, 1934 | ·04 | ·24 | ·06 | ·42 | ·09 | ·10 | 3·5 | 33·7 | 1·67 | Grass, mainly green, short. |
| | | Sept., 1934 | ·05 | ·22 | ·08 | ·59 | ·13 | ·21 | 4·7 | 33·3 | 1·79 | Grass, short. |
| | | Dec., 1934 | ·06 | ·22 | ·10 | ·87 | ·22 | ·38 | 5·1 | 34·9 | 2·48 | Grass, mainly green, leafy. |
| | | Mar., 1935 | ·044 | ·23 | ·06 | ·29 | ·09 | ·10 | 3·4 | 33·4 | 1·50 | Grass, mainly brown, leafy. |
| | | June, 1935 | ·07 | ·27 | ·10 | ·46 | ·03 | ·13 | 4·9 | 36·0 | 1·95 | Grass, mainly green, short. |
| | | Sept., 1935 | ·085 | ·49 | ·08 | ·55 | ·09 | ·19 | 5·2 | 31·7 | 2·67 | Grass, mainly green, short. |
| **Kruisfontein**..... | Alexandria..... | Jan., 1934 | ·24 | ·24 | ·08 | 1·42 | ·09 | ·46 | 8·5 | 37·2 | 3·43 | Grass, mainly green. |
| | | April, 1934 | ·26 | ·28 | ·13 | 1·86 | ·42 | ·73 | 8·4 | 31·1 | 4·76 | Grass, mainly green. |
| | | July, 1934 | ·32 | ·24 | ·12 | 1·19 | ·21 | ·33 | 12·4 | 29·2 | 3·41 | Grass, mainly green, short. |
| | | Oct., 1934 | ·39 | ·38 | ·15 | 1·82 | ·56 | ·53 | 9·3 | 29·9 | 4·82 | Grass, green. |
| | | April, 1935 | ·23 | ·41 | ·13 | 1·69 | ·41 | ·39 | 12·2 | 28·7 | 4·63 | Grass, mainly green, leafy. |
| | | July, 1935 | ·29 | ·33 | ·13 | 1·68 | ·35 | ·52 | 11·4 | 31·0 | 5·74 | Grass, mainly green, short. |
| | | Oct., 1935 | ·28 | ·93 | ·20 | 2·71 | ·41 | 1·07 | 12·8 | 31·3 | 8·16 | Grass, green and bush: mostly grass. |
| **Glen Ovis**........ | Albany........ | Nov., 1933 | ·13 | ·79 | ·23 | 1·47 | ·41 | ·39 | 9·1 | 32·1 | 6·24 | Bush. |
| | | Feb., 1934 | ·23 | 1·12 | ·39 | 2·45 | ·62 | ·52 | 9·7 | 24·8 | 8·72 | Grass, mainly green and bush; mostly bush. |
| | | May, 1934 | ·30 | ·57 | ·27 | 1·85 | ·16 | ·52 | 7·2 | 35·1 | 4·98 | Grass and bush; mostly grass. |
| | | Aug., 1934 | ·14 | 1·22 | — | 1·38 | ·28 | ·35 | 8·5 | 30·3 | 5·78 | Grass, mainly brown and bush. |
| | | Mar., 1935 | ·048 | ·22 | ·07 | ·37 | ·06 | ·14 | 3·7 | 35·3 | 1·50 | Grass. |
| **Mayfield**......... | Albany........ | Dec., 1933 | ·07 | ·22 | ·09 | ·68 | ·03 | ·08 | 4·6 | 32·5 | 2·01 | Grass, short. |
| | | Mar., 1934 | ·056 | ·21 | ·08 | ·74 | ·02 | ·18 | 4·4 | 33·6 | 1·75 | Grass, short. |
| | | June, 1934 | ·042 | ·21 | ·07 | ·35 | ·02 | ·09 | 3·7 | 34·6 | 1·47 | Grass, short. |
| | | Sept., 1934 | ·06 | 25 | 10 | ·49 | ·06 | ·12 | 4·2 | 37·5 | 1·87 | Grass, mainly brown, short and bush; mostly grass. |

AREA 5 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sydney's Hope... | Albany........ | Jan., 1934 | ·075 | ·34 | ·12 | ·89 | ·19 | ·26 | — | 37·6 | 3·88 | Grass, green, short and bush. |
| | | April, 1934 | ·087 | ·52 | ·11 | ·74 | ·09 | ·19 | 6·7 | 35·5 | 2·54 | Grass, short and bush; mostly grass. |
| | | July, 1934 | ·046 | ·28 | ·06 | ·41 | ·01 | ·09 | 3·9 | 34·5 | 1·54 | Grass, mainly brown, short. |
| | | Oct., 1934 | ·082 | ·29 | ·10 | ·57 | ·12 | ·22 | 5·3 | 35·2 | 2·23 | Grass, mainly green, short. |
| | | April, 1935 | ·14 | ·85 | ·77 | 2·35 | 1·25 | ·88 | 11·3 | 20·6 | 9·78 | Bush. |
| Mountain Home.. | Kingwilliamstown | Nov., 1933 | ·11 | ·26 | ·09 | ·75 | ·06 | ·12 | 5·0 | 34·5 | 2·28 | Grass. |
| | | Feb., 1934 | ·24 | ·22 | ·09 | 1·52 | ·36 | ·17 | 10·5 | 32·4 | 3·91 | Grass, mainly green. |
| | | May, 1934 | ·17 | ·38 | ·15 | ·85 | ·19 | ·42 | 5·2 | 35·5 | 2·66 | Grass, leafy. |
| | | Aug., 1934 | ·13 | ·31 | ·14 | ·87 | ·24 | ·33 | 5·6 | 35·5 | 2·71 | Grass, mainly brown. |
| | | Nov., 1934 | ·17 | ·37 | ·14 | 1·33 | ·42 | ·64 | 10·8 | 33·5 | 4·05 | Grass, mainly green. |
| | | Jan., 1935 | ·18 | ·32 | ·17 | 1·39 | ·35 | ·73 | 8·7 | 33·2 | 4·08 | Grass, mainly green. |
| | | Mar., 1935 | ·15 | ·27 | ·07 | ·54 | ·11 | ·15 | 4·0 | 35·0 | 1·94 | Grass, mainly green. |
| | | July, 1935 | ·13 | ·26 | ·08 | ·53 | ·08 | ·19 | 4·7 | 37·1 | 1·85 | Grass, leafy. |
| | | Oct., 1935 | ·08 | ·26 | ·24 | ·62 | ·03 | ·09 | 4·9 | 36·0 | 2·25 | Grass, mainly brown. |
| Fort Cox........ | Kingwilliamstown | Dec., 1933 | ·11 | ·24 | ·24 | 1·37 | ·16 | ·40 | 7·2 | 34·8 | 3·27 | Grass, mainly green. |
| | | Mar., 1934 | ·13 | ·50 | ·15 | 1·23 | ·11 | ·29 | 7·6 | 35·8 | 3·28 | Grass, mainly green. |
| | | June, 1934 | ·13 | ·42 | ·14 | 1·04 | ·20 | ·39 | 7·0 | 34·5 | 3·24 | Grass and bush; mostly grass. |
| | | Sept., 1934 | ·11 | ·36 | ·35 | ·60 | ·07 | ·12 | 6·6 | 35·9 | 2·29 | Grass and bush; mostly grass. |
| | | Nov., 1934 | ·17 | ·24 | ·28 | 1·42 | ·17 | ·48 | 8·3 | 33·5 | 3·44 | Grass, mainly green. |
| | | Feb., 1935 | ·14 | ·33 | ·23 | ·99 | ·33 | ·35 | 7·7 | 32·7 | 3·28 | Grass, green and bush; mostly grass. |
| | | April, 1935 | ·18 | ·51 | ·19 | ·89 | ·32 | ·39 | 9·4 | 33·4 | 3·44 | Grass, mainly green, leafy. |
| | | May, 1935 | ·18 | ·33 | ·37 | 1·22 | ·25 | ·19 | 10·5 | 34·2 | 3·52 | Grass, mainly green and bush; mostly grass. |
| | | Aug., 1935 | ·12 | ·76 | ·40 | ·74 | ·30 | ·30 | 9·9 | 26·4 | 3·94 | Grass, mainly green and bush; mostly grass. |
| Mngqesha........ | Kingwilliamstown | Jan., 1934 | ·098 | ·31 | ·14 | 1·25 | ·15 | ·54 | 7·0 | 34·2 | 2·93 | Grass, mainly green. |
| | | April, 1934 | ·13 | ·39 | ·17 | ·92 | ·20 | ·41 | 7·2 | 34·8 | 2·97 | Grass, mainly green. |
| | | July, 1934 | ·15 | ·33 | ·08 | ·54 | ·13 | ·21 | 4·4 | 35·5 | 2·16 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·077 | ·22 | ·11 | ·49 | ·05 | ·11 | 5·0 | 34·3 | 1·89 | Grass. |
| | | June, 1935 | ·12 | ·33 | ·10 | ·66 | ·08 | ·23 | 4·4 | 37·8 | 2·34 | Grass. |
| | | Sept., 1935 | ·11 | ·28 | ·10 | ·82 | ·10 | ·43 | 6·7 | 37·1 | 2·42 | Grass, mainly green. |
| Bekruipkop...... | Kingwilliamstown | Nov., 1933 | ·053 | ·48 | ·10 | ·63 | ·06 | ·32 | 4·5 | 40·0 | 2·49 | Grass, mainly brown. |
| | | Feb., 1934 | ·093 | ·29 | ·09 | ·83 | ·12 | ·24 | 5·3 | 34·4 | 2·63 | Grass, mainly green. |
| | | May, 1934 | ·073 | ·20 | ·15 | ·77 | ·07 | ·36 | 5·7 | 33·9 | 2·22 | Grass, leafy. |
| | | Aug., 1934 | ·068 | ·22 | ·10 | ·45 | ·05 | ·12 | 4·1 | 34·5 | 1·68 | Grass, mainly brown, leafy. |
| | | April, 1935 | ·11 | ·64 | ·11 | ·91 | ·11 | ·26 | 7·8 | 35·7 | 2·22 | Grass, mainly green. |

AREA 5 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Welcome Wood.. | Kingwilliamstown | Dec., 1933 | ·08 | ·22 | ·13 | ·95 | ·08 | ·39 | 5·7 | 36·4 | 2·64 | Grass, mainly green. |
| | | Mar., 1934 | ·10 | ·21 | ·09 | ·73 | ·12 | ·22 | 5·9 | 36·2 | 2·06 | Grass, mainly green. |
| | | June, 1934 | ·087 | ·19 | ·11 | ·71 | ·13 | ·25 | 4·3 | 35·7 | 2·08 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·056 | ·21 | ·11 | ·54 | ·06 | ·16 | 4·8 | 35·7 | 1·85 | Grass. |
| | | Mar., 1935 | ·08 | ·28 | ·17 | 1·14 | ·17 | ·41 | 5·7 | 33·9 | 2·45 | Grass, mainly green. |
| Cornfield......... | Kingwilliamstown | Jan., 1934 | ·12 | ·18 | ·10 | 1·34 | ·17 | ·51 | 8·2 | 37·4 | 3·19 | Grass, mainly green. |
| | | April, 1934 | ·08 | ·24 | ·10 | ·86 | ·11 | ·38 | 7·4 | 34·3 | 2·38 | Grass, mainly green, short. |
| | | July, 1934 | ·12 | ·23 | ·12 | ·81 | ·12 | ·36 | 4·5 | 35·9 | 2·35 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·07 | ·17 | ·09 | ·64 | ·07 | ·13 | 4·9 | 35·0 | 1·73 | Grass. |
| | | Feb., 1935 | ·067 | ·50 | ·20 | ·95 | ·12 | ·37 | 5·1 | 33·2 | 3·28 | Grass, mainly brown and bush; mostly grass. |
| | | May, 1935 | ·092 | ·40 | ·17 | ·92 | ·16 | ·41 | 6·9 | 32·3 | 3·07 | Grass, mainly green, short. |
| Thornpark....... | Kingwilliamstown | Jan., 1934 | ·15 | ·24 | ·12 | 2·00 | ·20 | ·62 | 10·2 | 36·4 | 4·07 | Grass, mainly green. |
| | | July, 1934 | ·077 | ·34 | ·10 | ·61 | ·08 | ·19 | 4·5 | 39·6 | 2·08 | Grass, mainly brown. |
| | | Mar., 1935 | ·20 | ·40 | ·12 | 1·23 | ·31 | ·39 | 6·7 | 32·0 | 3·63 | Grass, green, leafy. |
| Kingsdale........ | Kingwilliamstown | Feb., 1934 | ·21 | ·18 | ·09 | 1·86 | ·32 | ·71 | 6·4 | 39·4 | 4·44 | Grass, mainly green. |
| | | June, 1935 | ·084 | ·32 | ·13 | ·63 | ·08 | ·20 | 5·5 | 35·1 | 2·17 | Grass, leafy. |
| Allandale........ | Victoria East.. | Nov., 1933 | ·32 | ·36 | ·19 | 2·83 | ·27 | ·88 | 13·4 | 32·7 | 6·42 | Grass, green. |
| | | Aug., 1934 | ·068 | ·29 | — | ·50 | ·05 | ·14 | 5·8 | 35·6 | 1·81 | Grass, mainly brown. |
| Blackwoods...... | Victoria East.. | Mar., 1934 | ·11 | ·32 | ·11 | 1·20 | ·04 | ·29 | 6·3 | 39·1 | 2·75 | Grass, mainly green. |
| | | June, 1934 | ·09 | ·40 | ·10 | ·54 | ·04 | ·14 | 4·1 | 34·3 | 2·03 | Grass, mainly brown. |
| Binfield Park.... | Victoria East.. | Jan., 1934 | ·11 | ·20 | ·16 | ·98 | ·01 | ·33 | 6·7 | 36·8 | 2·70 | Grass, mainly green. |
| | | Nov., 1934 | ·078 | ·31 | ·11 | ·71 | ·02 | ·16 | 5·5 | 34·2 | 2·03 | Grass, leafy. |
| Rietfontein....... | Fort Beaufort.. | Feb., 1934 | ·18 | 1·06 | ·33 | 1·70 | ·17 | ·69 | 9·7 | 28·3 | 6·60 | Grass and bush. |
| | | May, 1934 | ·17 | ·51 | ·20 | 2·04 | ·42 | ·68 | 8·3 | 32·7 | 5·47 | Grass, mainly green and bush; mostly grass. |
| | | Aug., 1934 | ·13 | ·71 | — | 1·14 | ·28 | ·53 | 6·8 | 29·9 | 4·24 | Grass, leafy and bush; mostly grass. |
| | | Dec., 1934 | ·15 | ·44 | ·21 | 1·83 | ·25 | ·83 | 7·8 | 38·0 | 4·71 | Grass, mainly green. |
| | | Mar., 1935 | ·19 | ·33 | ·16 | 1·02 | ·33 | ·15 | 6·3 | 36·4 | 3·19 | Grass, leafy. |
| | | June, 1935 | ·16 | ·42 | ·21 | 1·30 | ·17 | ·41 | 11·2 | 31·1 | 5·33 | Grass, mainly green. |
| | | Sept., 1935 | ·13 | ·41 | ·13 | 1·06 | ·13 | ·26 | 7·9 | 35·3 | 3·14 | Grass, leafy. |

## AREA 5 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Contest.......... | Fort Beaufort.. | Dec., 1933 | ·27 | ·22 | 14 | 2·55 | ·16 | ·91 | 11·0 | 33·3 | 5·51 | Grass, green. |
| | | Mar., 1934 | ·11 | ·25 | ·14 | 1·26 | ·04 | ·28 | 7·3 | 33·6 | 2·98 | Grass mainly green, short. |
| | | June, 1934 | ·17 | ·40 | ·18 | 2·17 | ·14 | 1·00 | 8·9 | 33·0 | 5·34 | Grass, leafy. |
| | | Sept., 1934 | ·12 | ·49 | ·11 | ·82 | ·54 | ·36 | 6·8 | 36·0 | 3·70 | Grass, mainly brown, short and bush: mostly grass. |
| | | Jan., 1935 | ·15 | ·29 | ·17 | 1·86 | ·09 | ·84 | 8·7 | 33·9 | 4·19 | Grass, mainly green, leafy. |
| | | April, 1935 | 13 | 30 | ·15 | 1·41 | 08 | ·13 | 8·0 | 33·9 | 3·29 | Grass, mainly green, leafy. |
| | | July, 1935 | ·19 | ·40 | ·19 | 2·56 | 15 | 1·02 | 10·1 | 28·4 | 5·53 | Grass, mainly green, leafy. |
| | | Oct., 1935 | ·13 | ·34 | ·15 | ·84 | ·05 | ·29 | 5·9 | 34·3 | 2·39 | Grass, mainly brown, leafy. |
| Nieuweling....... | Adelaide....... | Jan., 1934 | ·19 | ·68 | ·32 | 2·21 | 1·38 | 1·62 | 8·3 | 27·8 | 9·36 | Grass and bush. |
| | | April, 1934 | ·16 | ·32 | ·12 | 1·66 | ·40 | ·50 | 6·1 | 33·1 | 4·23 | Grass, mainly green and bush; mostly grass. |
| | | June, 1934 | ·10 | ·41 | 15 | 1·03 | ·88 | 57 | 5·6 | 35·6 | 4·00 | Grass, short and bush; mostly grass. |
| | | Oct., 1934 | ·12 | ·51 | ·19 | ·99 | ·67 | ·43 | 7·9 | 35·8 | 3·39 | Grass, mainly brown and bush. |
| | | Feb., 1935 | ·12 | ·37 | ·19 | 1·52 | 75 | ·71 | 7·8 | 36·5 | 4·72 | Grass, mainly green and bush; mostly grass. |
| | | May, 1935 | ·11 | ·34 | ·10 | 1·37 | ·23 | ·33 | 6·8 | 38·7 | 4·72 | Grass, mainly green, leafy and bush. |
| | | Aug., 1935 | ·14 | ·90 | ·23 | 1·25 | ·82 | ·60 | 9·3 | 32·6 | 7·19 | Bush. |
| | | Nov., 1935 | ·12 | ·49 | ·21 | 1·51 | ·65 | ·57 | 8·5 | 38·1 | 5·04 | Grass, green, short and bush; mostly bush. |
| Oskraal.......... | Bedford....... | Nov., 1933 | ·26 | ·29 | ·17 | 2·07 | ·32 | ·52 | 10·6 | 31·7 | 5·16 | Grass, green, short and bush. |
| | | Feb., 1934 | ·16 | ·26 | ·13 | 1·80 | ·25 | ·56 | 8·7 | 36·8 | 4·00 | Grass, mainly green, short. |
| | | May, 1934 | ·17 | ·47 | ·17 | 1·49 | ·27 | ·69 | 4·5 | 35·7 | 4·13 | Grass, mainly green. |
| | | Nov., 1934 | ·12 | ·24 | ·10 | 1·32 | ·07 | ·45 | 7·0 | 32·3 | 3·07 | Grass, mainly green, short. |
| | | April, 1935 | ·092 | ·27 | ·08 | ·62 | ·06 | ·13 | 4·6 | 32·5 | 2·30 | Grass, short. |
| | | July, 1935 | ·12 | ·45 | ·08 | ·76 | ·05 | ·23 | 7·0 | 33·3 | 2·93 | Grass, mainly green, short, and bush; mostly grass. |
| Request......... | Bedford....... | Dec., 1933 | ·22 | ·32 | ·17 | 2·42 | ·52 | 1·15 | 10·5 | 31·6 | 6·07 | Grass, mainly green and bush; mostly grass. |
| | | Mar., 1934 | ·19 | ·31 | ·13 | 1·42 | ·08 | ·42 | 7·5 | 36·2 | 3·33 | Grass, mainly green. |
| | | June, 1934 | ·16 | ·42 | ·12 | ·92 | ·13 | ·30 | 5·8 | 34·2 | 2·96 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·096 | ·44 | ·08 | ·69 | ·18 | ·18 | 6·1 | 39·3 | 2·44 | Grass, mainly brown and bush. |
| | | Feb., 1935 | ·19 | ·28 | ·11 | 1·68 | ·19 | ·53 | 6·9 | 33·9 | 4·04 | Grass, mainly green, short. |
| | | May, 1935 | ·11 | ·42 | ·12 | ·92 | ·11 | ·29 | 6·6 | 35·2 | 7·28 | Grass, mainly green, short and bush; mostly grass. |
| | | Aug., 1935 | ·14 | ·27 | ·11 | ·71 | ·06 | ·19 | 5·9 | 35·6 | 2·26 | Grass, mainly brown, short. |

## AREA 5 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Krugerskraal**..... | Bedford........ | Jan., 1934 | ·13 | ·36 | ·18 | 1·41 | ·22 | ·39 | 7·7 | 40·9 | 3·77 | Grass, mainly green and bush. |
| | | April, 1934 | ·12 | ·40 | ·14 | 1·41 | ·47 | ·40 | 6·7 | 35·3 | 3·68 | Grass, mainly green, short and bush; mostly grass. |
| | | July, 1934 | ·096 | ·64 | ·15 | ·87 | ·56 | ·27 | 6·5 | 38·5 | 4·09 | Grass, mainly brown, short and bush. |
| | | Oct., 1934 | ·094 | ·53 | ·22 | ·90 | ·17 | ·22 | 5·7 | 39·6 | 3·10 | Grass, brown and bush. |
| | | Mar., 1935 | ·08 | ·49 | ·10 | ·76 | ·18 | ·11 | 6·1 | 39·4 | 2·98 | Grass, mainly green and bush; mostly bush. |
| | | June, 1935 | ·19 | ·93 | ·45 | 2·00 | 1·42 | ·28 | 11·3 | 26·7 | 9·28 | Bush. |
| | | Sept., 1935 | — | ·42 | ·12 | 1·20 | ·16 | — | 9·5 | 33·5 | 3·82 | Grass, green, short and bush; mostly grass. |
| **Karkotskraal**..... | Somerset East.. | Nov., 1933 | ·26 | ·60 | ·32 | 3·05 | 1·64 | 1·61 | 14·8 | 29·5 | 9·72 | Bush. |
| | | Feb., 1934 | ·08 | ·37 | ·13 | 1·24 | ·12 | ·33 | 8·1 | 39·7 | 3·40 | Grass, mainly green and bush; mostly grass. |
| | | May, 1934 | ·19 | ·54 | ·14 | 1·43 | ·29 | ·37 | 6·5 | 41·3 | 3·89 | Grass, short and bush; mostly bush. |
| | | Aug., 1934 | ·094 | ·29 | — | ·75 | ·16 | ·19 | 5·4 | 40·7 | 2·26 | Grass, mainly brown and bush; mostly grass. |
| | | Nov., 1934 | ·068 | ·48 | ·13 | 1·22 | ·41 | ·43 | 7·1 | 42·3 | 4·52 | Bush. |
| | | Feb., 1935 | ·22 | ·53 | ·19 | 2·33 | ·36 | ·55 | 10·2 | 34·4 | 6·14 | Bush. |
| | | May, 1935 | ·21 | ·57 | ·14 | 1·89 | ·25 | ·53 | 12·3 | 36·8 | 5·36 | Grass and bush. |
| | | Aug., 1935 | ·15 | ·60 | ·19 | 1·26 | ·60 | ·36 | 9·3 | 39·4 | 4·64 | Bush. |
| **Rietfontein**....... | Somerset East.. | Dec., 1933 | ·22 | ·51 | ·27 | 2·71 | ·90 | 1·00 | 14·0 | 31·4 | 8·21 | Grass, green and bush. |
| | | Mar., 1934 | ·15 | ·34 | ·23 | 1·69 | ·37 | ·59 | 11·2 | 32·2 | 5·25 | Grass, mainly green and bush; mostly grass. |
| | | June, 1934 | ·21 | ·67 | ·23 | 1·23 | 1·14 | ·93 | 10·5 | 37·4 | 8·46 | Bush. |
| | | Sept., 1934 | ·11 | ·53 | ·12 | 1·64 | ·38 | ·27 | 6·4 | 46·2 | 4·44 | Bush. |
| | | Dec., 1934 | ·098 | ·55 | ·12 | ·59 | ·39 | ·19 | 6·0 | 46·0 | 4·05 | Bush. |
| | | Mar., 1935 | ·096 | ·46 | ·12 | 1·43 | ·43 | ·21 | 7·2 | 39·4 | 3·97 | Grass, green and bush; mostly bush. |
| | | June, 1935 | ·24 | ·47 | ·17 | 2·12 | ·22 | ·71 | 13·7 | 30·4 | 5·39 | Grass, green, short. |
| | | Sept., 1935 | ·21 | ·80 | ·46 | 2·28 | 1·59 | 1·28 | 15·4 | 30·2 | 10·18 | Bush. |
| **Wentworth**....... | Somerset East.. | Jan., 1934 | ·26 | ·66 | ·30 | 2·19 | 1·85 | ·96 | 13·3 | 34·3 | 10·03 | Bush. |
| | | April, 1934 | ·30 | ·72 | ·36 | 2·90 | ·59 | ·79 | 11·9 | 30·7 | 7·78 | Grass, mainly green and bush; mostly grass. |
| | | July, 1934 | ·23 | ·60 | ·23 | 1·88 | 1·25 | ·80 | 10·5 | 33·7 | 7·20 | Grass, leafy and bush. |
| | | Oct., 1934 | ·21 | ·55 | ·29 | 1·63 | ·94 | ·86 | 9·9 | 32·8 | 7·40 | Bush. |
| | | Jan., 1935 | ·18 | ·49 | ·20 | 1·51 | ·58 | ·60 | 8·5 | 40·1 | 5·29 | Bush. |
| | | April, 1935 | ·20 | ·64 | ·27 | 2·33 | 1·27 | ·26 | 10·8 | 34·3 | 7·84 | Grass and bush; mostly bush. |
| | | July, 1935 | ·18 | ·70 | ·19 | 1·59 | ·67 | ·55 | 10·0 | 40·1 | 5·56 | Bush. |
| | | Oct., 1935 | ·29 | ·68 | ·39 | 3·56 | ·51 | 1·13 | 15·8 | 34·5 | 9·62 | Grass and bush. |

### Area 6.

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mount Prospect.. | Herschel....... | Oct., 1933 | ·13 | ·94 | ·26 | ·76 | ·02 | ·08 | 10·0 | 21·4 | 6·04 | Bush. |
| | | Feb., 1934 | ·13 | ·25 | ·15 | 1·93 | ·03 | ·38 | 3·9 | 38·4 | 3·83 | Grass, long. |
| | | April, 1934 | ·12 | ·18 | ·05 | ·93 | ·03 | ·20 | 4·8 | 35·9 | 1·76 | Grass. |
| | | July, 1934 | ·074 | ·26 | ·09 | ·55 | ·01 | ·12 | 2·7 | 38·5 | 1·56 | Grass, mainly brown. |
| | | Oct., 1934 | ·064 | ·34 | ·12 | ·41 | ·02 | ·06 | 3·8 | 37·4 | 1·61 | Grass, mainly brown. |
| | | Mar., 1935 | ·066 | ·26 | ·11 | ·81 | trace | ·04 | 3·9 | 41·6 | 1·92 | Grass, mainly green, long. |
| | | Sept., 1935 | ·056 | ·24 | ·04 | ·18 | ·02 | ·05 | 4·2 | 39·0 | 1·19 | Grass, brown. |
| Josanashoek...... | Herschel....... | Nov., 1933 | ·10 | ·42 | ·12 | ·56 | ·02 | ·06 | 5·4 | 30·6 | 2·79 | Grass, mainly brown and bush; mostly grass. |
| | | Mar., 1934 | ·11 | ·23 | ·15 | 2·39 | ·04 | ·25 | 6·9 | 35·5 | 4·38 | Grass, mainly green. |
| | | Aug., 1934 | ·05 | ·30 | ·11 | ·48 | trace | ·06 | 2·7 | 38·8 | 1·50 | Grass, mainly brown. |
| | | Feb., 1935 | ·13 | ·33 | ·04 | ·62 | ·02 | ·09 | 4·2 | 33·1 | 1·49 | Grass. |
| | | April, 1935 | ·075 | ·30 | ·11 | ·49 | trace | ·08 | 3·6 | 37·4 | 1·60 | Grass, mainly brown. |
| | | June, 1935 | ·06 | ·23 | ·07 | ·29 | trace | ·07 | 3·4 | 39·9 | 1·31 | Grass, mainly brown. |
| | | July, 1935 | ·07 | ·24 | ·09 | ·45 | ·03 | ·11 | 3·7 | 40·2 | 1·33 | Grass, mainly brown. |
| | | Oct., 1935 | ·05 | ·25 | ·05 | ·25 | trace | ·01 | 3·7 | 39·7 | 1·32 | Grass, mainly brown. |
| Kranspruit....... | Herschel....... | Dec., 1933 | ·32 | ·26 | ·17 | 3·26 | ·05 | ·50 | 15·2 | 32·5 | 6·49 | Grass, green. |
| | | Mar., 1934 | ·18 | ·26 | ·08 | 1·13 | ·02 | ·23 | 4·5 | 35·5 | 2·66 | Grass. |
| | | May, 1934 | ·13 | ·39 | ·15 | ·93 | ·03 | ·23 | 4·1 | 36·7 | 2·77 | Grass. |
| | | June, 1934 | ·16 | ·30 | ·05 | ·75 | ·01 | ·17 | 3·5 | 38·9 | 2·02 | Grass, brown. |
| | | Sept., 1934 | ·062 | ·36 | ·14 | ·34 | trace | ·09 | 3·7 | 37·2 | 1·79 | Grass, mainly brown. |
| | | Feb., 1935 | ·064 | ·19 | ·06 | ·60 | trace | ·06 | 5·6 | 40·0 | 1·34 | Grass, long. |
| | | May, 1935 | ·073 | ·21 | ·05 | ·35 | ·02 | ·08 | 3·8 | 36·9 | 1·23 | Grass, mainly brown. |
| | | Aug., 1935 | ·044 | ·26 | ·09 | ·39 | ·01 | ·12 | 3·9 | 35·9 | 1·41 | Grass, mainly brown. |
| Malpas.......... | Barkley East... | Nov., 1933 | ·068 | ·34 | ·12 | ·41 | ·01 | ·12 | 4·3 | 35·1 | 2·07 | Grass, mainly brown. |
| | | Feb., 1934 | ·31 | ·80 | ·27 | 2·84 | ·04 | ·38 | 8·2 | 25·2 | 10·20 | Grass, mainly green and bush. |
| | | May, 1934 | ·17 | ·54 | ·16 | 1·46 | ·03 | ·35 | 6·7 | 32·7 | 3·50 | Grass and bush; mostly grass. |
| | | Aug., 1934 | ·14 | ·43 | ·17 | ·88 | ·01 | ·16 | 5·8 | 33·6 | 2·84 | Grass, mainly brown, leafy. |
| | | Nov., 1934 | ·25 | ·48 | ·18 | 2·04 | ·05 | ·38 | 14·2 | 27·5 | 4·78 | Grass, mainly green, leafy and bush; mostly grass. |
| | | Feb., 1935 | ·22 | ·37 | ·14 | 1·46 | trace | ·76 | 10·1 | 28·1 | 3·67 | Grass, green, leafy. |
| | | May, 1935 | ·18 | ·35 | ·12 | ·93 | ·02 | ·14 | 5·4 | 34·7 | 2·42 | Grass, leafy. |
| | | Aug., 1935 | ·083 | ·30 | ·11 | ·55 | trace | ·14 | 3·3 | 38·3 | 1·79 | Grass, mainly brown, leafy. |
| Earlstown........ | Barkley East... | Dec., 1933 | ·33 | 1·22 | ·42 | 4·04 | ·06 | ·48 | 19·6 | 22·7 | 11·70 | Grass, green, leafy and bush; mostly bush. |
| | | Mar., 1934 | ·18 | ·88 | ·31 | 2·20 | ·06 | ·28 | 9·4 | 32·1 | 6·40 | Grass and bush. |
| | | June, 1934 | ·20 | ·68 | ·18 | 1·29 | ·02 | ·18 | 9·0 | 31·1 | 3·83 | Grass, leafy. |
| | | Sept., 1934 | ·18 | ·47 | ·15 | 1·15 | ·03 | ·21 | 10·6 | 31·7 | 3·14 | Grass, leafy and bush; mostly grass. |
| | | Dec., 1934 | ·27 | ·48 | ·18 | 2·38 | ·08 | ·39 | 12·6 | 31·6 | 5·12 | Grass, green, leafy. |
| | | Mar., 1935 | ·09 | ·31 | ·13 | 1·57 | ·03 | ·31 | 8·3 | 35·3 | 3·28 | Grass, green, leafy. |
| | | June, 1935 | ·17 | ·26 | ·12 | 1·24 | ·02 | ·26 | 7·0 | 35·1 | 2·98 | Grass, mainly green. |
| | | Sept., 1935 | ·15 | ·27 | ·08 | ·67 | ·02 | ·16 | 5·3 | 38·3 | 2·02 | Grass, brown, leafy. |

## AREA 6 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Glass Neven.....** | Barkley East... | Jan., 1934 | ·22 | ·49 | ·24 | 2·74 | ·06 | ·45 | 12·5 | 33·0 | 6·27 | Grass, green and bush; mostly grass. |
| | | April, 1934 | ·18 | ·56 | ·22 | 2·35 | ·07 | ·42 | 10·8 | 31·2 | 5·02 | Grass, mainly green and bush; mostly grass. |
| | | July, 1934 | ·09 | ·35 | ·12 | ·70 | ·01 | ·12 | 4·3 | 33·1 | 1·90 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·16 | ·60 | ·20 | 1·52 | ·04 | ·43 | 10·1 | 30·6 | 4·30 | Grass, mainly green, leafy and bush; mostly grass. |
| | | Jan., 1935 | ·20 | ·55 | ·23 | 1·95 | trace | ·38 | 9·1 | 31·6 | 4·36 | Grass, green, leafy. |
| | | April, 1935 | ·17 | ·52 | ·24 | 2·03 | ·06 | ·55 | 10·7 | 30·0 | 4·88 | Grass, mainly green, leafy. |
| | | July, 1935 | ·12 | ·35 | ·10 | ·78 | ·03 | ·16 | 5·0 | 33·4 | 2·09 | Grass, mainly brown, leafy. |
| | | Oct., 1935 | ·17 | ·35 | ·12 | 1·35 | ·04 | ·33 | 6·8 | 35·8 | 3·33 | Grass, mainly green, leafy. |
| **Grootvlei........** | Barkley East... | Nov., 1933 | ·11 | ·41 | ·20 | ·58 | ·02 | ·20 | 5·4 | 33·3 | 2·51 | Grass, mainly brown. |
| | | Feb., 1934 | ·24 | ·31 | ·12 | 1·50 | ·03 | ·19 | 8·6 | 33·6 | 3·72 | Grass, green, short. |
| | | May, 1934 | ·21 | ·42 | ·17 | 1·13 | ·04 | ·15 | 7·7 | 32·6 | 5·10 | Grass, mainly green, leafy. |
| | | Aug., 1934 | ·17 | ·65 | ·24 | 1·08 | ·01 | ·18 | 8·4 | 30·1 | 3·99 | Grass, mainly brown, short and bush. |
| | | Nov., 1934 | ·23 | ·33 | ·14 | 1·25 | trace | ·18 | 11·9 | 29·5 | 3·05 | Grass, green, leafy. |
| | | Feb., 1935 | ·19 | ·27 | ·10 | 1·29 | ·03 | ·76 | 9·2 | 30·2 | 2·85 | Grass, green, leafy. |
| | | May, 1935 | ·15 | ·26 | ·09 | ·59 | ·02 | ·08 | 4·3 | 32·6 | 1·83 | Grass, mianly green, leafy. |
| | | Aug., 1935 | ·15 | ·28 | ·10 | ·49 | ·03 | ·08 | 4·1 | 33·2 | 1·85 | Grass, mainly brown, leafy. |
| **The Falls........** | Barkley East... | Dec., 1933 | ·29 | ·28 | ·22 | 1·29 | ·04 | ·18 | 13·1 | 28·4 | 3·56 | Grass, mainly green, short. |
| | | Mar., 1934 | ·16 | ·34 | ·14 | ·98 | ·04 | ·12 | 9·1 | 36·2 | 2·48 | Grass, mainly green. |
| | | June, 1934 | ·23 | ·39 | ·20 | ·87 | ·02 | ·14 | 6·3 | 29·7 | 3·34 | Grass, leafy, and bush; mostly grass. |
| | | Sept., 1934 | ·08 | ·37 | ·10 | ·31 | ·01 | ·04 | 3·9 | 30·3 | 1·83 | Grass, brown, leafy. |
| | | Dec., 1934 | ·24 | ·31 | ·12 | 1·47 | ·05 | ·24 | 11·2 | 31·4 | 3·12 | Grass, green, leafy. |
| | | Mar., 1935 | ·24 | ·35 | ·17 | 1·10 | ·06 | ·21 | 5·8 | 33·3 | 3·01 | Grass, green, leafy. |
| | | June, 1935 | ·13 | ·26 | ·09 | ·48 | trace | ·07 | 4·4 | 33·1 | 1·83 | Grass, mainly brown, short. |
| | | Sept., 1935 | ·07 | ·21 | ·03 | ·24 | ·07 | ·16 | 3·4 | 33·2 | 1·67 | Grass, brown, short. |
| **Zevenfontein.....** | Barkley East... | Jan., 1934 | ·31 | ·44 | ·22 | 2·26 | ·06 | ·37 | 17·2 | 24·8 | 5·19 | Grass, green. |
| | | April, 1934 | ·17 | ·29 | ·10 | ·69 | ·04 | ·09 | 7·0 | 32·9 | 1·79 | Grass, mainly green. |
| | | July, 1934 | ·11 | ·25 | ·12 | ·37 | trace | ·08 | 3·5 | 34·3 | 1·58 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·16 | ·56 | ·11 | ·54 | ·02 | ·08 | 5·2 | 34·3 | 2·13 | Grass, brown, leafy. |
| | | Jan., 1935 | ·16 | ·26 | ·10 | ·80 | ·04 | ·36 | 6·9 | 30·5 | 2·23 | Grass, green, leafy. |
| | | April, 1935 | ·12 | ·32 | ·13 | ·68 | ·04 | ·09 | 6·3 | 28·5 | 2·12 | Grass, green, short. |
| | | July, 1935 | ·18 | ·30 | ·11 | ·53 | ·02 | ·12 | 4·9 | 34·1 | 1·88 | Grass, mainly brown, leafy. |
| | | Oct., 1935 | ·19 | ·34 | ·14 | ·94 | trace | ·21 | 10·3 | 33·3 | 2·80 | Grass, green. |

AREA 6 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Bamboeshoek....** | Lady Grey..... | Nov., 1933 | ·08 | ·17 | ·07 | ·48 | ·01 | ·09 | 4·1 | 36·4 | 1·64 | Grass, mainly brown. |
| | | Mar., 1934 | ·22 | ·23 | ·08 | 1·34 | ·03 | ·13 | 8·2 | 35·7 | 2·86 | Grass, mainly green. |
| | | June, 1934 | ·13 | ·36 | ·12 | ·98 | ·03 | ·10 | 6·4 | 31·0 | 2·79 | Grass, mainly green and bush : mostly grass. |
| | | Sept., 1934 | ·12 | ·40 | ·11 | ·55 | ·02 | ·08 | 6·5 | 35·9 | 1·75 | Grass, mainly brown. |
| | | Nov., 1934 | ·13 | ·31 | ·12 | 1·41 | trace | ·22 | 10·3 | 35·9 | 2·95 | Grass, green, long. |
| | | Feb., 1935 | ·19 | ·40 | ·14 | 1·36 | trace | ·83 | 8·4 | 32·9 | 3·16 | — |
| | | May, 1935 | ·072 | ·27 | ·07 | ·34 | trace | ·07 | 4·8 | 40·6 | 1·47 | Grass. |
| | | Aug., 1935 | ·08 | ·25 | ·09 | ·51 | trace | ·08 | 4·8 | 37·1 | 3·43 | Grass, brown. |
| **Burnet..........** | Lady Grey..... | Dec., 1933 | ·27 | ·35 | ·17 | 2·06 | ·03 | ·43 | 10·4 | 34·1 | 5·04 | Grass, green and bush ; mostly grass. |
| | | Feb., 1934 | ·21 | ·24 | ·11 | 1·67 | ·04 | ·18 | 8·2 | 34·2 | 3·42 | Grass, mainly green |
| | | May. 1934 | 086 | ·49 | ·16 | ·68 | 01 | ·07 | 5·4 | 35·4 | 2·40 | Grass, mainly brown and bush ; mostly grass. |
| | | Aug., 1934 | ·11 | ·30 | ·13 | 16 | ·01 | ·13 | 4·6 | 32·7 | 1·90 | Grass, mainly brown. |
| | | Nov., 1934 | ·11 | ·26 | ·09 | ·56 | trace | ·14 | 5·4 | 33·1 | 1·79 | Grass. |
| | | Jan., 1935 | ·15 | ·17 | ·10 | 1·51 | ·03 | ·24 | 5·7 | 35·9 | 2·66 | Grass, mainly green. |
| | | April, 1935 | ·14 | ·38 | ·11 | ·74 | ·02 | ·08 | 5·4 | 34·3 | 1·81 | Grass, mainly green. |
| | | July, 1935 | ·06 | ·33 | ·11 | ·29 | ·02 | ·13 | 3·1 | 36·8 | 1·38 | Grass, mainly brown. |
| | | Oct., 1935 | 096 | ·20 | ·06 | ·46 | 04 | ·06 | 4·4 | 40·4 | 1·36 | Grass. |
| Zachtvlei........ | Lady Grey..... | Jan., 1934 | ·25 | ·34 | ·12 | 1·80 | ·05 | ·28 | 10·8 | 34·4 | 4·00 | Grass, mainly green. |
| | | April, 1934 | ·17 | 29 | ·09 | 1 21 | ·04 | ·13 | 5·6 | 35·8 | 2·42 | Grass. |
| | | July, 1934 | ·14 | ·55 | ·12 | ·78 | ·02 | ·11 | 6·0 | 34·3 | 2·58 | Grass, mainly brown and bush ; mostly grass. |
| | | Oct., 1934 | ·12 | ·27 | ·15 | ·68 | ·01 | ·08 | 5·3 | 36·0 | 2·17 | Grass, mainly brown, and bush ; mostly grass. |
| | | Dec., 1934 | ·22 | ·26 | ·12 | 1·54 | ·05 | ·24 | 8·2 | 37·2 | 3·29 | Grass, mainly green. |
| | | Mar., 1935 | ·13 | ·37 | ·10 | ·76 | ·02 | ·10 | 4·3 | 37·6 | 2·62 | Grass, mainly brown. |
| | | June, 1935 | ·11 | ·34 | ·10 | ·63 | trace | ·11 | 5·7 | 35·2 | 2·20 | Grass. |
| | | Sept., 1935 | ·10 | 28 | ·08 | ·66 | ·04 | ·09 | 6·4 | 33·1 | 2·50 | Grass. |
| Antelope Park... | Maclear........ | Nov., 1933 | ·18 | ·21 | ·18 | 1·86 | ·02 | ·60 | 13·8 | 34·2 | 4·98 | Grass, mainly green, short. |
| | | Feb., 1934 | ·16 | ·26 | ·10 | 1·16 | ·03 | ·22 | 8·3 | 34·9 | 3·81 | Grass, green. |
| | | May, 1934 | 076 | ·27 | ·11 | ·84 | ·02 | ·21 | 6·5 | 31·5 | 2·03 | Grass, mainly green, leafy. |
| | | Aug., 1934 | ·047 | ·23 | ·08 | ·23 | trace | ·03 | 4·5 | 31·6 | 1·48 | Grass, mainly brown, short. |
| | | Nov., 1934 | ·16 | ·26 | ·11 | 1·40 | trace | ·28 | 10·5 | 32·0 | 3·03 | Grass, green, short. |
| | | Feb., 1935 | ·16 | ·32 | ·09 | 1·22 | ·02 | ·11 | 8·5 | 35·7 | 2·65 | Grass, green, short. |
| | | May, 1935 | ·13 | ·30 | ·12 | ·94 | ·04 | ·13 | 6·3 | 33·1 | 2·30 | Grass, mainly green, short. |
| | | Aug., 1935 | ·07 | ·26 | ·10 | ·26 | ·02 | ·09 | 4·8 | 33·9 | 1·53 | Grass, brown, short. |

## AREA 6 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chamisso........ | Maclear........ | Dec., 1933 | ·16 | ·30 | ·13 | 1·91 | ·04 | ·39 | 11·5 | 36·0 | 4·10 | Grass, mainly green. |
| | | Mar., 1934 | ·12 | ·24 | ·12 | 1·15 | ·01 | ·19 | 8·3 | 34·9 | 2·37 | Grass, green, short. |
| | | June, 1934 | ·044 | ·29 | ·07 | ·34 | trace | ·14 | 4·1 | 31·4 | 1·65 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·19 | ·18 | ·09 | 1·41 | ·06 | ·44 | 10·5 | 35·0 | 2·94 | Grass, green. |
| | | Dec., 1934 | ·11 | ·20 | ·11 | 1·31 | trace | ·33 | 10·6 | 34·6 | 2·59 | Grass, green, short. |
| | | Mar., 1935 | ·11 | ·27 | ·09 | 1·45 | trace | ·20 | 7·0 | 31·3 | 2·67 | Grass, green, short. |
| | | June, 1935 | ·085 | ·29 | ·09 | ·28 | trace | ·14 | 4·7 | 32·9 | 1·87 | Grass, short. |
| | | Sept., 1935 | ·07 | ·27 | ·05 | ·53 | ·03 | ·10 | 4·1 | 32·9 | 1·60 | Grass, brown, short. |
| Elandsheight..... | Maclear........ | Jan., 1934 | ·17 | ·26 | ·18 | 4·22 | ·10 | 1·62 | 15·2 | 33·4 | 8·66 | Grass, green. |
| | | April, 1934 | ·095 | ·28 | ·11 | 1·08 | ·02 | ·19 | 6·6 | 33·9 | 2·48 | Grass, mainly green, leafy. |
| | | July, 1934 | ·057 | ·19 | ·10 | ·31 | trace | ·08 | 5·2 | 32·0 | 1·52 | Grass, mainly brown, short. |
| | | Oct., 1934 | ·16 | ·29 | ·13 | 1·36 | ·05 | ·52 | 13·0 | 30·5 | 3·12 | Grass, mainly green, short. |
| | | Jan., 1935 | ·16 | ·26 | ·12 | 2·10 | ·03 | ·39 | 9·5 | 33·1 | 3·72 | Grass, green, short. |
| | | April, 1935 | ·11 | ·31 | ·12 | 1·00 | ·06 | ·27 | 7·7 | 31·4 | 2·51 | Grass, green, short. |
| | | July, 1935 | ·082 | ·27 | ·09 | ·39 | ·07 | ·14 | 4·9 | 33·6 | 1·92 | Grass, brown, short. |
| | | Oct., 1935 | ·11 | ·26 | ·09 | ·71 | ·01 | ·15 | 8·7 | 32·8 | 2·23 | Grass, mainly green, short. |
| Rosslyn Park.... | Maclear........ | Nov., 1933 | ·15 | ·20 | ·11 | 1·38 | ·04 | ·35 | 10·1 | — | 2·91 | Grass, mainly green. |
| | | Feb., 1934 | ·18 | ·29 | ·12 | 1·19 | ·02 | ·20 | 6·4 | 34·7 | 2·60 | Grass, mainly green, short. |
| | | May, 1934 | ·036 | ·38 | ·11 | ·39 | ·01 | ·10 | 4·0 | 34·2 | 1·72 | Grass, mainly brown, short. |
| | | Nov., 1934 | ·10 | ·26 | ·14 | 1·48 | trace | ·35 | 6·8 | 37·5 | 2·78 | Grass, green, leafy. |
| | | April, 1935 | ·072 | ·28 | ·11 | ·34 | trace | ·16 | 4·6 | 34·3 | 1·81 | Grass, mainly green, leafy. |
| | | Oct., 1935 | ·12 | ·26 | ·14 | 1·43 | ·07 | ·47 | 7·9 | 36·5 | 3·05 | Grass, green, leafy. |
| Sunnyslope....... | Maclear........ | Dec., 1933 | ·20 | ·32 | ·17 | 1·66 | ·02 | ·33 | 11·7 | 31·8 | 3·65 | Grass, mainly green, short. |
| | | Mar., 1934 | ·11 | ·39 | ·15 | ·88 | ·01 | ·16 | 5·8 | 35·3 | 2·34 | Grass, short. |
| | | June, 1934 | ·086 | ·34 | ·08 | ·34 | trace | ·04 | — | 31·0 | 1·74 | Grass, mainly brown, short. |
| | | Jan., 1935 | ·10 | ·29 | ·11 | 1·19 | ·15 | ·22 | 5·9 | 34·9 | 2·38 | Grass, green, leafy. |
| | | Feb., 1935 | ·092 | ·27 | ·09 | ·95 | trace | ·19 | 6·1 | 34·5 | 1·97 | Grass, green, leafy. |
| | | Sept.. 1935 | ·16 | ·25 | ·13 | 1·96 | ·04 | ·56 | 12·2 | 32·6 | 4·01 | Grass, green, short. |
| Orpen........... | Maclear........ | Jan., 1934 | ·11 | ·29 | ·12 | 1·09 | ·02 | ·20 | 6·9 | 33·3 | 3·00 | Grass, green, short. |
| | | April, 1934 | ·066 | ·39 | ·13 | ·57 | ·02 | ·14 | 4·7 | 34·8 | 1·87 | Grass, short. |
| | | July, 1934 | ·04 | ·23 | ·07 | ·15 | trace | ·04 | 3·3 | 33·4 | 1·13 | Grass, brown, leafy. |
| | | Oct., 1934 | ·17 | — | — | — | — | ·37 | 8·4 | 34·0 | 3·12 | Grass, green, leafy. |
| | | Mar., 1935 | ·082 | ·37 | ·11 | ·83 | ·07 | ·19 | 6·5 | 31·3 | 2·45 | Grass, green, short. |
| | | May, 1935 | ·086 | ·28 | ·10 | ·52 | ·01 | ·21 | 4·6 | 33·4 | 2·05 | Grass, short. |
| Idylla........... | Elliot.......... | Nov., 1933 | ·15 | ·40 | ·16 | 1·39 | ·32 | — | 10·4 | 31·2 | 3·44 | Grass, mainly green, short. |
| | | Feb., 1934 | ·11 | ·32 | ·14 | 1·16 | ·24 | ·26 | 6·6 | 33·3 | 2·58 | Grass, leafy. |
| | | May, 1934 | ·063 | ·37 | ·11 | ·66 | ·02 | ·14 | 4·3 | 33·2 | 1·86 | Grass, short. |
| | | Feb., 1935 | ·15 | ·19 | ·06 | 1·34 | trace | ·17 | 6·3 | 40·1 | 2·77 | Grass. |
| | | May, 1935 | ·16 | ·23 | ·07 | ·96 | ·02 | ·16 | 6·5 | 38·0 | 2·41 | Grass, leafy. |
| | | Aug., 1935 | ·086 | ·30 | ·13 | ·59 | ·08 | ·18 | 4·6 | 37·6 | 2·06 | Grass, brown. |

AREA 6 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rooipoort........ | Elliot.......... | Mar., 1934 | ·13 | ·41 | ·12 | 1·07 | ·03 | ·20 | 7·2 | 35·0 | 2·69 | Grass, mainly green, leafy. |
| | | June, 1934 | ·10 | ·24 | ·08 | ·91 | ·02 | ·21 | 4·9 | 33·7 | 2·22 | Grass, short. |
| | | Sept., 1934 | ·10 | ·37 | ·17 | ·83 | ·02 | ·20 | 6·4 | 32·9 | 2·73 | Grass. |
| | | Dec., 1934 | ·11 | ·26 | ·07 | 1·51 | ·03 | ·33 | 6·0 | 37·5 | 2·99 | Grass, mainly green. |
| | | Mar., 1935 | ·07 | ·23 | ·08 | ·81 | ·02 | ·16 | 6·1 | 34·8 | 1·79 | Grass, green, long. |
| | | July, 1935 | ·064 | ·29 | ·09 | ·35 | ·01 | ·12 | 4·2 | 41·3 | 1·40 | Grass, mainly brown, leafy. |
| Ekowa.......... | Elliot.......... | Jan., 1934 | ·15 | ·26 | ·10 | 1·29 | ·05 | ·25 | 8·9 | 34·4 | 2·90 | Grass, mainly green. |
| | | April, 1934 | ·22 | ·38 | ·13 | ·97 | ·02 | ·10 | 5·8 | 34·5 | 2·33 | Grass, short. |
| | | Oct., 1934 | ·18 | ·20 | ·13 | 1·34 | ·04 | ·29 | 11·1 | 29·7 | 3·20 | Grass, green, short. |
| | | Jan., 1935 | ·13 | ·28 | ·07 | 1·20 | ·03 | ·25 | 6·2 | 39·3 | 2·43 | Grass, mainly green, leafy. |
| | | April, 1935 | ·11 | ·32 | ·11 | ·84 | ·04 | ·16 | 6·1 | 34·1 | 2·29 | Grass, mainly green. |
| | | June, 1935 | ·068 | ·24 | ·06 | ·45 | ·02 | ·09 | 4·2 | 39·8 | 1·55 | Grass, mainly brown. |
| | | Oct., 1935 | ·087 | ·22 | ·07 | ·60 | ·01 | ·12 | 3·1 | 37·5 | 1·60 | Grass. |
| Carlton.......... | Woodhouse.... | Nov., 1933 | ·066 | ·26 | ·08 | ·29 | ·01 | ·07 | 4·1 | 35·3 | 1·76 | Grass, brown, short. |
| | | Feb., 1934 | ·20 | ·31 | ·20 | 1·76 | ·05 | ·39 | 8·9 | 29·8 | 3·78 | Grass, mainly green. |
| | | May, 1934 | ·098 | ·39 | ·12 | ·70 | ·01 | ·15 | 5·1 | 32·8 | 2·48 | Grass, leafy. |
| | | Aug., 1934 | ·06 | ·33 | ·09 | ·15 | trace | ·02 | 3·5 | 32·1 | 1·38 | Grass, brown, leafy. |
| | | Nov., 1934 | ·11 | ·29 | ·09 | ·71 | ·02 | ·16 | 7·1 | 32·4 | 1·98 | Grass, green, short. |
| | | Feb., 1935 | ·13 | ·40 | ·10 | ·86 | ·02 | ·14 | 6·2 | 31·7 | 2·42 | Grass, mainly green, short. |
| | | May, 1935 | ·15 | ·42 | ·12 | ·46 | ·02 | ·07 | 4·5 | 30·0 | 2·60 | Grass, mainly green, short. |
| | | Oct., 1935 | ·16 | ·38 | ·14 | 1·15 | ·27 | ·36 | 10·1 | 30·6 | 3·10 | Grass, mainly green, short. |
| Uitkyk.......... | Woodhouse.... | Dec., 1933 | ·25 | ·36 | ·13 | 2·08 | ·05 | ·39 | 12·1 | 31·1 | 4·39 | Grass, mainly green. |
| | | Mar., 1934 | ·16 | ·33 | — | 1·20 | ·03 | ·25 | 8·2 | 32·4 | 3·07 | Grass, mainly green, short. |
| | | June, 1934 | ·12 | ·32 | ·08 | ·52 | ·02 | ·10 | 3·8 | 31·9 | 1·97 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·085 | ·28 | ·07 | ·28 | ·01 | ·06 | 4·7 | 32·9 | 1·42 | Grass, brown, leafy. |
| | | Dec., 1934 | ·17 | ·31 | ·09 | 1·16 | ·12 | ·17 | 9·5 | 29·7 | 2·77 | Grass, green, short. |
| | | Mar., 1935 | ·14 | ·33 | ·10 | 1·09 | ·09 | ·30 | 5·8 | 32·6 | 2·68 | Grass, green, short. |
| | | Aug., 1935 | ·13 | ·36 | ·11 | ·65 | ·02 | ·10 | 3·6 | 32·7 | 2·17 | Grass, mainly brown, short. |
| Mount Victory... | Woodhouse.... | Jan., 1934 | ·22 | ·23 | ·14 | 1·81 | ·05 | ·39 | 12·0 | 30·2 | 4·01 | Grass, mainly green, short. |
| | | April, 1934 | ·19 | ·29 | ·11 | 1·05 | ·03 | ·15 | 8·7 | 33·9 | 2·26 | Grass, mainly green, short. |
| | | July, 1934 | ·096 | ·35 | ·08 | ·32 | trace | ·05 | 3·6 | 31·9 | 1·70 | Grass, brown, leafy. |
| | | Oct., 1934 | ·16 | ·27 | ·10 | ·85 | ·02 | ·11 | 7·5 | 31·1 | 2·38 | Grass, leafy. |
| | | Jan., 1935 | ·18 | ·31 | ·12 | 1·56 | ·04 | ·34 | 7·9 | 30·8 | 3·26 | Grass, green, leafy. |
| | | April, 1935 | ·16 | ·30 | ·08 | ·80 | ·02 | ·15 | 6·4 | 29·7 | 2·43 | Grass, mainly green, short. |
| | | Sept., 1935 | ·11 | ·30 | ·06 | 1·13 | ·03 | ·18 | 7·4 | 29·5 | 2·34 | Grass, short. |
| Anniesdale....... | Wepener....... | Jan., 1934 | ·20 | ·21 | ·11 | 1·68 | ·03 | ·34 | 8·2 | 38·7 | 3·69 | Grass, green. |
| | | April, 1934 | ·11 | ·26 | ·09 | ·97 | ·02 | ·17 | 4·9 | 38·3 | 2·20 | Grass, mainly green, long. |
| | | July, 1934 | ·10 | ·25 | ·11 | ·42 | ·01 | ·09 | 2·7 | 38·0 | 1·76 | Grass, brown. |
| | | Sept., 1934 | ·063 | ·14 | ·08 | ·14 | trace | ·02 | 2·1 | 39·0 | 1·17 | Grass, brown. |
| | | Jan., 1935 | ·18 | ·25 | ·09 | 1·58 | ·04 | ·30 | 7·2 | 35·0 | 3·17 | Grass, green, long. |
| | | April, 1935 | ·12 | ·33 | ·12 | ·52 | ·02 | ·08 | 5·0 | 33·9 | 1·91 | Grass, green, leafy. |
| | | Aug., 1935 | ·063 | ·19 | ·11 | ·16 | trace | ·07 | 2·7 | 35·7 | 1·22 | Grass, brown. |

## AREA 6 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kruispoort....... | Wepener....... | Feb., 1934 | ·23 | ·27 | ·14 | 1·65 | ·05 | ·35 | 7·6 | 32·4 | 4·00 | Grass, mainly green. |
| | | May, 1934 | ·068 | ·30 | ·10 | ·42 | trace | ·04 | 2·9 | 40·2 | 1·66 | Grass, mainly brown, long. |
| | | Aug., 1934 | ·054 | ·30 | ·09 | ·18 | trace | ·01 | 2·5 | 40·0 | 1·26 | Grass, brown. |
| | | Nov., 1934 | ·18 | ·23 | ·10 | 1·10 | ·03 | ·24 | 9·9 | 33·3 | 2·48 | Grass, green, long. |
| | | Feb., 1935 | ·20 | ·30 | ·13 | 1·13 | ·05 | ·30 | 6·5 | 34·7 | 2·77 | Grass, green, long. |
| | | June, 1935 | ·07 | ·24 | ·06 | ·25 | trace | ·03 | 2·7 | 35·8 | 1·28 | Grass, brown, leafy. |
| | | Oct., 1935 | ·14 | ·24 | ·06 | ·60 | ·02 | ·11 | 5·8 | 34·4 | 1·87 | Grass, mainly brown, leafy. |
| Yzervarkfontein.. | Smithfield...... | Dec., 1933 | ·45 | ·42 | ·26 | 1·96 | ·30 | ·40 | 17 0 | 28·3 | 6·06 | Grass, green, leafy. |
| | | May, 1934 | ·15 | ·46 | ·11 | ·69 | ·03 | ·12 | 5·6 | 34·8 | 2·47 | Grass. |
| Gronigen......... | Smithfield...... | Jan.‘ 1934 | ·23 | ·23 | ·17 | 2·08 | ·03 | ·35 | 11·9 | 33·2 | 4·08 | Grass, green.; |
| | | May, 1934 | ·18 | ·49 | ·14 | ·90 | ·03 | ·15 | 5·1 | 31·8 | 3·04 | Grass, mainly green. |
| Mangazana....... | Smithfield...... | Feb., 1934 | ·19 | ·29 | ·17 | 1·81 | 03 | ·10 | 9·2 | 35·8 | 3·72 | Grass, mainly green. |
| | | June. 1934 | ·22 | ·34 | ·10 | ·96 | ·04 | ·13 | 4·7 | 35·1 | 2·65 | Grass, mainly brown, leafy. |
| Evening Star..... | Ladybrand..... | Jan.‘ 1934 | ·17 | ·23 | ·10 | 1·66 | ·08 | ·36 | 10·3 | 32·1 | 3·84 | Grass, green. |
| | | Nov., 1934 | ·11 | ·21 | ·09 | 1 43 | trace | ·28 | 8·5 | 36·3 | 2·51 | Grass, mainly green, long. |
| | | April, 1935 | ·15 | 25 | ·07 | ·59 | 02 | 08 | 3·9 | 38·8 | 1·86 | Grass, mainly brown, long. |
| McCabespruit..... | Ladybrand..... | May, 1934 | ·10 | ·30 | ·12 | ·69 | ·02 | ·14 | 4·0 | 35·2 | 2·01 | Grass, mainly brown. |
| | | Oct., 1934 | ·13 | ·18 | ·07 | ·79 | 03 | ·09 | 7·2 | 36·8 | 1·95 | Grass, green, long. |
| | | Jan., 1935 | ·10 | ·18 | ·09 | 1·64 | trace | ·36 | 4·6 | 43·5 | 3·23 | Grass, long. |
| Ebrenbrachstein.. | Ladybrand..... | Aug., 1934 | ·075 | — | ·09 | ·28 | ·03 | ·02 | 6·3 | 35·0 | 1·37 | Grass, brown. |
| | | Mar., 1935 | ·16 | ·30 | ·07 | ·75 | ·03 | ·10 | 4·8 | 37·7 | 2·03 | Grass, mainly green, long. |
| | | May, 1935 | ·16 | ·31 | ·08 | ·68 | ·02 | ·13 | 4·6 | 39·4 | 2·08 | Grass, long. |
| St· Mark......... | Zastron......... | Jan., 1934 | ·16 | ·24 | ·14 | 1·67 | ·03 | ·35 | 11·1 | 36·3 | 3·40 | Grass, mainly green. |
| | | April, 1934 | ·096 | ·26 | ·10 | 1·21 | ·03 | ·25 | 6·4 | 30·7 | 2·49 | Grass, mainly green. |
| | | July, 1934 | ·10 | ·28 | ·09 | ·51 | ·01 | ·07 | 3·6 | 36·2 | 1·69 | Grass, brown. |
| | | Oct.‘ 1934 | ·13 | ·23 | ·12 | ·90 | ·02 | ·25 | 8·9 | 34·1 | 2·75 | Grass, mainly green. |
| | | Jan., 1935 | ·17 | ·30 | ·11 | 1·52 | ·04 | ·41 | 7·0 | 34·9 | 3·27 | Grass, green. |
| | | April, 1935 | ·14 | ·30 | ·12 | ·78 | ·06 | ·14 | 5·1 | 34·4 | 2·26 | Grass, mainly green. |
| | | July, 1935 | ·095 | ·21 | ·087 | ·46 | ·01 | ·05 | 2·6 | 37·4 | 1·52 | Grass, brown. |
| | | Oct., 1935 | ·21 | ·28 | ·11 | 1·71 | ·03 | ·50 | 12·5 | 34·6 | 3·80 | Grass, green, leafy. |
| Rozendal........ | Zastron......... | Feb., 1934 | ·23 | ·21 | ·16 | 1·84 | 04 | ·72 | 7·5 | 36·7 | 3·65 | Grass, mainly green. |
| | | May, 1934 | ·15 | ·24 | ·19 | ·73 | ·03 | ·21 | 5·1 | 39·1 | 2·33 | Grass. |
| | | Aug., 1934 | ·10 | ·17 | ·17 | ·60 | ·01 | ·10 | 4·0 | 39·8 | 1·74 | Grass, brown. |
| | | Nov., 1934 | ·18 | ·28 | ·17 | 1·61 | trace | ·37 | 9·8 | 35·8 | 3·16 | Grass, mainly green, long. |
| | | Feb., 1935 | ·11 | ·21 | ·08 | ·84 | trace | ·14 | 4·6 | 38·7 | 1·88 | Grass, mainly green, leafy. |
| | | May, 1935 | ·15 | ·23 | ·19 | 1·18 | ·09 | ·36 | 7·8 | 36·4 | 2·91 | Grass, mainly green, leafy. |
| | | Aug., 1935 | ·08 | ·23 | ·11 | ·45 | ·03 | ·11 | 4·5 | 36·1 | 2·00 | Grass, mainly brown, leafy. |

AREA 6 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kalkhoek........ | Zastron........ | Mar., 1934 | ·18 | ·31 | ·11 | 1·42 | ·03 | ·25 | 5·5 | 36·5 | 3·29 | Grass, mainly green. |
| | | June, 1934 | ·097 | ·30 | ·07 | ·73 | ·02 | ·12 | 3·8 | 37·1 | 2·05 | Grass, mainly brown. |
| | | Sept., 1934 | ·13 | ·33 | ·14 | ·42 | ·03 | ·05 | 3·2 | 35·2 | 1·75 | Grass, brown. |
| | | Dec., 1934 | ·18 | ·25 | ·16 | 2·21 | ·12 | ·46 | 8·6 | 37·3 | 3·99 | Grass, mainly green. |
| | | Mar., 1935 | ·21 | ·28 | ·07 | ·78 | trace | ·12 | 5·4 | 36·8 | 2·12 | Grass, leafy. |
| | | June, 1935 | ·14 | ·24 | ·08 | ·57 | trace | ·10 | 3·8 | 36·7 | 1·66 | Grass, brown. |
| | | Sept., 1935 | ·17 | ·53 | ·09 | ·88 | ·07 | ·13 | 6·3 | 34·4 | 3·43 | Grass. |
| Welgegund....... | Vrede......... | Dec., 1933 | ·15 | ·40 | ·18 | 1·53 | ·04 | ·32 | 9·1 | 34·5 | 3·42 | Grass, green, |
| | | July, 1934 | ·025 | ·39 | ·11 | ·13 | ·02 | ·02 | 4·3 | 33·9 | 1·50 | Grass, mainly brown, short. |
| | | Feb., 1935 | ·094 | ·28 | ·10 | ·76 | ·06 | ·21 | 4·8 | 35·3 | 1·99 | Grass, mainly green, leafy. |
| | | Aug., 1935 | ·085 | ·30 | ·08 | ·33 | ·04 | ·08 | 3·0 | 37·5 | 1·58 | Grass, brown, short. |
| Venterskloof..... | Vrede......... | Jan., 1934 | ·10 | ·34 | ·12 | ·97 | ·02 | ·16 | 6·5 | 31·4 | 2·71 | Grass, mainly green, short. |
| | | Aug., 1934 | ·047 | ·36 | ·09 | ·12 | trace | ·02 | 2·9 | 32·5 | 1·22 | Grass, brown, leafy. |
| | | April, 1935 | ·088 | ·47 | ·16 | ·42 | trace | ·19 | 4·3 | 30·8 | 2·11 | Grass, mainly green, short. |
| Aanvang......... | Vrede......... | June, 1934 | ·042 | ·42 | ·15 | ·42 | trace | ·07 | 3·1 | 32·6 | 1·84 | Grass, brown, leafy. |
| | | Sept., 1934 | ·053 | ·37 | ·05 | ·22 | trace | ·03 | 6·0 | 32·5 | 1·56 | Grass, mainly brown, leafy. |
| | | Jan., 1935 | ·096 | ·39 | ·12 | — | ·02 | ·11 | 4·4 | 31·8 | 2·28 | Grass, mainly green, leafy. |
| | | June, 1935 | ·05 | ·34 | ·07 | ·21 | trace | ·05 | 3·5 | 33·6 | 1·31 | Grass, brown, leafy. |
| Rondedraai...... | Harrismith..... | April, 1935 | ·14 | ·30 | ·10 | ·86 | ·06 | ·18 | 6·4 | 33·8 | 2·21 | Grass, mainly green, leafy. |
| | | July, 1935 | ·062 | ·20 | ·08 | ·26 | trace | ·05 | 2·5 | 37·7 | 1·20 | Grass, brown. |
| | | Oct., 1935 | ·047 | ·20 | ·04 | ·14 | ·04 | — | 3·2 | 38·1 | 1·18 | Grass, brown. |
| De Hoop........ | Harrismith..... | May, 1935 | ·096 | ·31 | ·13 | ·79 | ·01 | ·11 | 3·1 | 39·4 | 2·09 | Grass, mainly brown. |
| | | Aug., 1935 | ·05 | ·25 | ·07 | ·32 | trace | ·01 | 3·0 | 39·6 | 1·41 | Grass, brown, leafy. |
| De Villiers....... | Harrismith..... | June, 1935 | ·055 | ·23 | ·11 | ·50 | trace | ·04 | 3·7 | 40·1 | 1·37 | Grass, mainly brown. |
| | | Sept., 1935 | ·082 | ·28 | ·07 | ·27 | ·02 | ·03 | 2·9 | 35·3 | 1·51 | Grass, brown, leafy. |
| Shorthorn........ | Frankfort...... | Dec., 1933 | ·18 | ·38 | ·17 | 1·64 | ·04 | ·34 | 10·1 | 33·0 | 3·65 | Grass, mainly green and bush; mostly grass. |
| | | Mar., 1934 | ·08 | ·58 | ·21 | 1·03 | ·02 | ·16 | 5·9 | 34·5 | 3·32 | Grass, mainly green, and bush; mostly grass. |
| | | July, 1934 | ·035 | ·61 | ·19 | ·13 | trace | ·01 | 2·9 | 37·9 | 2·25 | Grass, brown and bush; mostly grass. |
| | | Dec., 1934 | ·25 | ·49 | ·22 | 1·66 | ·36 | ·41 | 9·6 | 31·7 | 5·50 | Grass, mainly green, and bush; mostly grass. |
| | | Jan., 1935 | ·14 | ·32 | ·21 | 2·05 | ·03 | ·34 | 6·9 | 34·8 | 4·06 | Grass, green, and bush; mostly grass. |
| | | June, 1935 | ·054 | ·24 | ·06 | ·19 | trace | ·04 | 2·9 | 43·0 | 1·11 | Grass, brown, leafy. |
| | | Aug., 1935 | ·11 | ·45 | ·23 | ·85 | ·04 | ·32 | 5·0 | 35·3 | 3·13 | Grass, mainly brown, leafy. |

### AREA 6 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Egge............ | Frankfort...... | Jan., 1934 | ·15 | ·45 | ·23 | 1·48 | ·02 | ·28 | 8·8 | 39·8 | 4·37 | Grass, mainly green and bush; mostly grass. |
| | | April, 1934 | ·07 | ·53 | ·16 | ·90 | ·02 | ·19 | 5·5 | 34·8 | 2·87 | Grass and bush; mostly grass. |
| | | July, 1934 | ·036 | ·38 | ·15 | ·11 | ·01 | ·02 | 3·4 | 38·1 | 1·46 | Grass, brown. |
| | | Nov., 1934 | ·18 | ·46 | ·20 | 2·15 | ·13 | ·57 | 11·1 | 35·2 | 4·62 | Grass, leafy and bush; mostly grass. |
| | | May, 1935 | ·084 | ·64 | ·24 | ·74 | ·02 | ·16 | 4·6 | 37·5 | 3·10 | Grass, brown and bush; mostly grass. |
| | | Oct., 1935 | ·067 | ·26 | ·06 | ·18 | ·02 | ·02 | 4·0 | 35·8 | 1·45 | Grass, brown, leafy. |
| Sandput......... | Frankfort...... | Feb., 1934 | ·083 | ·17 | ·07 | 1·20 | ·01 | ·29 | 3·9 | 41·3 | 2·14 | Grass, mainly green, long. |
| | | May, 1934 | ·05 | ·37 | ·13 | ·45 | ·01 | ·12 | 4·6 | 38·9 | 1·95 | Grass, mainly brown, and bush; mostly grass. |
| | | Sept., 1934 | ·067 | ·23 | ·10 | ·36 | trace | ·06 | 5·2 | 39·8 | 1·46 | Grass, mainly brown. |
| | | Feb., 1935 | ·14 | ·40 | ·19 | 1·41 | trace | ·16 | 7·1 | 34·5 | 3·13 | Grass, mainly green. |
| | | April, 1935 | ·086 | ·46 | ·13 | ·69 | trace | ·02 | 4·7 | 34·6 | 2·36 | Grass, mainly brown, leafy and bush; mostly grass. |
| | | Sept., 1935 | ·07 | ·30 | ·08 | ·29 | ·02 | ·02 | 4·5 | 37·9 | 1·78 | Grass, brown, leafy. |
| Sebastopol....... | Bethlehem..... | Dec., 1933 | ·13 | ·38 | ·14 | 1·99 | ·05 | ·32 | 11·1 | 31·6 | 4·27 | Grass, mainly green. |
| | | Mar., 1934 | ·11 | ·27 | ·15 | 1·24 | ·05 | ·24 | 5·5 | 33·4 | 2·89 | Grass, green. |
| | | May, 1934 | ·046 | ·29 | ·11 | ·58 | ·01 | ·11 | 3·9 | 36·4 | 1·75 | Grass, mainly brown, long. |
| | | Oct., 1934 | ·12 | ·20 | ·12 | 1·33 | ·04 | ·27 | 8·4 | 31·9 | 2·81 | Grass, green. |
| | | Jan., 1935 | ·097 | ·26 | ·13 | 1·14 | ·02 | ·28 | 6·1 | 32·7 | 2·29 | Grass, green. |
| | | April, 1935 | ·11 | ·32 | ·12 | ·78 | ·06 | ·14 | 4·8 | 34·4 | 3·38 | Grass, mainly green, leafy. |
| Drakenstein...... | Bethelem...... | Jan., 1934 | ·27 | ·24 | ·16 | 2·05 | ·06 | ·44 | 13·0 | 32·1 | 4·31 | Grass, mainly green, short. |
| | | April, 1934 | ·098 | ·31 | ·14 | 1·13 | ·02 | ·15 | 5·1 | 33·3 | 2·65 | Grass, mainly green. |
| | | July, 1934 | ·057 | ·31 | ·08 | ·11 | trace | ·02 | 3·7 | 35·2 | 1·29 | Grass, brown, leafy. |
| | | Nov., 1934 | ·09 | ·19 | ·09 | ·95 | trace | ·20 | 5·6 | 35·0 | 1·88 | Grass, mainly green. |
| | | Feb., 1935 | ·07 | ·33 | ·12 | 1·35 | trace | ·24 | 5·2 | 32·6 | 2·90 | Grass, green, leafy. |
| | | May, 1935 | ·08 | ·32 | ·10 | ·40 | trace | ·08 | 3·8 | 35·7 | 1·82 | Grass, brown, leafy. |
| Warsaw......... | Bethlehem..... | Feb., 1934 | ·12 | ·23 | ·14 | 1·64 | ·03 | ·27 | 9·3 | 33·1 | 3·38 | Grass, green, short. |
| | | June, 1934 | ·066 | ·33 | ·07 | ·18 | ·01 | ·02 | 2·7 | 34·6 | 1·44 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·06 | ·29 | ·06 | ·29 | trace | ·05 | 5·5 | 33·8 | 1·67 | Grass, mainly brown, leafy. |
| | | Dec., 1934 | ·077 | ·18 | ·08 | 1·09 | ·04 | ·17 | 4·8 | 37·0 | 2·13 | Grass, mainly green, long. |
| | | Mar., 1935 | ·10 | ·38 | ·11 | ·81 | ·02 | ·11 | 6·5 | 35·6 | 2·44 | Grass, green, leafy. |

AREA 6 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Driekuil......... | Bethlehem..... | Feb., 1934 | ·12 | ·26 | ·11 | 1·07 | ·03 | ·21 | 6·9 | 41·1 | 2·56 | Grass, mainly green. |
| | | Aug., 1934 | ·05 | ·28 | ·08 | ·09 | trace | Trace | 3·3 | 41·8 | 1·18 | Grass, brown, leafy. |
| | | Nov., 1934 | ·14 | ·25 | ·10 | 1·45 | trace | ·37 | 8·2 | 36·1 | 2·88 | Grass, mainly green. |
| | | Mar., 1935 | ·11 | ·42 | ·07 | ·73 | trace | ·12 | 4·3 | 38·5 | 2·22 | Grass, mainly green. |
| Grootkloof....... | Ficksburg...... | Dec., 1933 | ·20 | ·18 | ·11 | 1·67 | ·04 | ·30 | 6·0 | 34·8 | 3·59 | Grass, green. |
| | | Mar., 1934 | ·19 | ·23 | ·21 | 1·79 | ·05 | ·32 | 7·4 | 39·5 | 3·57 | Grass, mainly green. |
| | | June, 1934 | ·064 | ·23 | ·07 | ·44 | ·01 | ·06 | 4·0 | 35·4 | 1·45 | Grass, mainly brown. |
| | | Sept., 1934 | ·095 | ·31 | ·05 | ·41 | ·02 | ·06 | 6·2 | 33·0 | 1·67 | Grass, mainly brown, leafy. |
| | | Dec., 1934 | ·11 | ·28 | ·10 | 1·05 | trace | ·32 | 7·4 | 35·4 | 2·47 | Grass, green, leafy. |
| | | April, 1935 | ·11 | ·29 | ·07 | ·68 | trace | ·07 | 4·8 | 32·3 | 1·93 | Grass. |
| Tweefontein...... | Ficksburg...... | Jan., 1934 | ·26 | ·22 | ·14 | 2·15 | ·05 | ·41 | 10·5 | 36·8 | 4·53 | Grass, green. |
| | | April, 1934 | ·13 | ·26 | ·12 | 1·31 | ·03 | ·20 | 6·9 | 34·1 | 2·86 | Grass, mainly green. |
| | | July, 1934 | ·11 | ·36 | ·16 | ·98 | ·02 | ·23 | 5·7 | 34·0 | 2·60 | Grass, brown, leafy. |
| | | Oct., 1934 | ·10 | ·26 | ·06 | ·57 | ·02 | ·09 | 7·4 | 31·6 | 1·71 | Grass, mainly green, leafy. |
| | | Feb., 1935 | ·13 | ·21 | ·05 | ·65 | trace | ·13 | 5·1 | 35·9 | 1·51 | Grass. |
| | | May, 1935 | ·09 | ·22 | ·05 | ·30 | trace | ·05 | 4·2 | 38·0 | 1·10 | Grass, brown. |

## AREA 7.

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sterkspruit, P.O. Amersfoort | Wakkerstroom. | Nov., 1933 | ·19 | ·48 | ·15 | 1·27 | ·04 | ·32 | 11·8 | 31·7 | 3·20 | Grass, green, short. |
| | | Feb., 1934 | ·073 | ·24 | ·12 | 1·88 | ·03 | ·32 | 11·0 | 38·0 | 3·14 | Grass, mainly green.. |
| | | May, 1934 | ·025 | ·40 | ·16 | ·61 | ·02 | ·10 | 3·4 | 34·8 | 2·04 | Grass, mainly brown, leafy. |
| | | Aug., 1934 | ·024 | ·29 | ·11 | ·13 | ·01 | ·01 | 2·4 | 38·2 | 1·26 | Grass, brown, leafy. |
| | | Nov., 1934 | ·14 | ·35 | ·22 | 1·11 | ·03 | ·27 | 8·7 | 35·3 | 2·93 | Grass, green. |
| | | Feb., 1935 | ·075 | ·43 | ·19 | ·80 | trace | ·87 | 4·5 | 32·6 | 2·31 | Grass, mainly green. |
| | | May, 1935 | ·054 | ·29 | ·16 | ·21 | trace | ·051 | 2·5 | 34·4 | 1·44 | Grass, mainly brown, leafy. |
| | | Sept., 1935 | ·082 | ·29 | ·11 | ·09 | trace | ·025 | 2·1 | 39·0 | 1·41 | Grass, brown, leafy. |
| Koppieskraal, P.O. Amersfoort | Wakkerstroom. | Dec., 1933 | ·12 | ·49 | ·17 | 1·02 | ·03 | ·23 | 8·3 | 35·4 | 3·00 | Grass, green. |
| | | Mar., 1934 | ·093 | ·39 | ·16 | ·94 | ·02 | ·16 | 5·8 | 33·7 | 2·79 | Grass, mainly green. |
| | | June, 1934 | ·025 | ·38 | ·15 | ·16 | ·01 | ·03 | 4·3 | 40·1 | 1·38 | Grass, brown, leafy. |
| | | Sept., 1934 | ·028 | ·33 | ·11 | ·10 | trace | ·03 | 3·0 | 38·7 | 1·34 | Grass, brown, leafy. |
| | | Dec., 1934 | ·19 | ·37 | ·23 | ·92 | ·03 | ·16 | 7·4 | 34·4 | 2·32 | Grass, green, leafy. |
| | | Mar., 1935 | ·077 | ·31 | ·13 | ·77 | trace | ·10 | 4·8 | 35·5 | 1·91 | Grass, green. |
| | | June, 1935 | ·066 | ·34 | ·10 | ·26 | trace | ·05 | 2·7 | 33·9 | 1·41 | Grass, brown, short. |
| | | Oct., 1935 | ·037 | ·39 | ·04 | ·19 | ·02 | ·02 | 3·0 | 35·8 | 1·54 | Grass, brown, short. |
| Enon, P.O. Amersfoort | Wakkerstroom. | Jan., 1934 | ·10 | ·37 | ·13 | ·87 | ·03 | ·15 | — | 35·6 | 2·26 | Grass, green. |
| | | April, 1934 | ·048 | ·29 | ·09 | ·69 | ·01 | ·10 | 6·5 | 33·2 | 1·62 | Grass, leafy. |
| | | July, 1934 | ·032 | ·30 | ·08 | ·14 | trace | ·02 | 3·9 | 37·7 | 1·19 | Grass, brown, leafy. |
| | | Oct., 1934 | ·057 | ·23 | ·06 | ·26 | ·02 | ·05 | 4·1 | 37·5 | 1·63 | Grass, mainly green, leafy. |
| | | Jan., 1935 | ·10 | ·37 | ·15 | 1·04 | ·04 | ·22 | 6·2 | 36·3 | 2·48 | Grass, green. |
| | | April, 1935 | ·048 | ·36 | ·16 | ·67 | ·02 | ·08 | 3·2 | 33·6 | 2·10 | Grass, mainly green. |
| | | Aug., 1935 | ·051 | ·37 | ·13 | ·18 | trace | ·04 | 2·8 | 35·2 | 1·46 | Grass, brown, leafy. |
| Buitenzorg No. 308 | Wakkerstroom. | Nov., 1933 | ·23 | ·70 | ·18 | 1·91 | ·03 | ·48 | 12·3 | 32·9 | 5·48 | Grass, mainly green and bush. |
| | | Feb., 1934 | ·13 | ·35 | ·15 | 1·50 | ·02 | ·30 | 7·8 | 34·9 | 3·09 | Grass and shrub; mostly grass. |
| | | May, 1934 | ·078 | ·23 | ·11 | ·90 | trace | ·27 | 5·2 | 34·7 | 2·12 | Grass. |
| | | Aug., 1934 | ·10 | ·32 | ·18 | ·63 | ·01 | ·06 | 6·7 | 35·9 | 2·11 | Grass, brown, leafy. |
| | | Nov., 1934 | ·088 | ·26 | ·09 | ·61 | ·02 | ·18 | 5·5 | 31·7 | 1·75 | Grass, mainly brown, short. |
| | | Feb., 1935 | ·10 | ·30 | ·12 | 1·18 | ·07 | ·25 | 6·7 | 33·6 | 2·65 | Grass, green, short. |
| | | May, 1935 | ·084 | ·31 | ·08 | ·48 | ·02 | ·08 | 3·8 | 33·6 | 1·57 | Grass, leafy. |
| | | Aug., 1935 | ·045 | ·33 | ·10 | ·21 | ·02 | ·05 | 3·1 | 34·8 | 1·45 | Grass, brown, leafy. |
| Driefontein No. 107 | Wakkerstroom. | Dec., 1933 | ·17 | ·28 | ·13 | 1·61 | ·05 | ·35 | 8·4 | 35·9 | 3·37 | Grass, mainly green. |
| | | Mar., 1934 | ·11 | ·34 | ·14 | ·95 | trace | ·22 | 5·6 | 36·8 | 2·16 | Grass, mainly green, short. |
| | | June, 1934 | ·054 | ·32 | ·10 | ·19 | ·01 | ·05 | 4·3 | 32·3 | 1·60 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·046 | ·31 | ·06 | ·18 | trace | ·03 | 3·6 | 35·1 | 1·25 | Grass, brown, leafy. |
| | | Dec., 1934 | ·14 | ·32 | ·13 | 1·39 | ·03 | ·22 | 8·4 | 33·1 | 2·83 | Grass, green, short. |
| | | Mar., 1935 | ·12 | ·33 | ·12 | ·75 | trace | ·08 | 5·4 | 34·0 | 2·07 | Grass, mainly green, short. |
| | | June, 1935 | ·062 | ·30 | ·10 | ·40 | trace | ·07 | 3·6 | 35·7 | 1·46 | Grass, brown, short. |
| | | Sept., 1935 | ·039 | ·34 | ·09 | ·13 | ·02 | ·05 | 2·7 | 37·5 | 1·47 | Grass, brown, short. |

AREA 7 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mooiplaas No. 17. | Wakkerstroom. | Jan., 1934 | ·14 | ·39 | ·12 | ·98 | ·03 | ·17 | 7·2 | 37·8 | 2·57 | Grass, mainly green. |
| | | April, 1934 | ·17 | ·43 | ·13 | 1·40 | ·05 | ·27 | 7·8 | 29·3 | 3·06 | Grass, mainly green. |
| | | July, 1934 | ·067 | ·41 | ·09 | ·21 | trace | ·03 | 3·2 | 36·3 | 1·69 | Grass, brown, leafy. |
| | | Oct., 1934 | ·16 | ·26 | ·14 | 1·28 | ·04 | ·36 | 11·7 | 31·5 | 3·19 | Grass, leafy. |
| | | Jan., 1935 | ·13 | ·46 | ·13 | 1·25 | ·03 | ·28 | 7·8 | 36·9 | 3·11 | Grass, green, leafy. |
| | | April, 1935 | ·081 | ·34 | ·12 | ·66 | ·08 | ·09 | 4·6 | 32·1 | 2·01 | Grass, mainly green; short. |
| | | July, 1935 | ·072 | ·26 | ·07 | ·33 | trace | ·04 | 2·4 | 38·6 | 1·37 | Grass, brown, leafy. |
| | | Oct., 1935 | ·064 | ·27 | ·07 | ·33 | ·02 | ·02 | 4·8 | 33·4 | 1·50 | Grass, mainly brown, leafy. |
| Smalkloof, P.O. Volksrust | Wakkerstroom. | Nov., 1933 | ·17 | ·23 | ·13 | 1·56 | trace | ·33 | 8·9 | 36·2 | 3·32 | Grass, mainly green. |
| | | Feb., 1934 | ·12 | ·34 | ·11 | 1·12 | ·01 | ·16 | 7·2 | 34·0 | 2·81 | Grass, mainly green, short. |
| | | May, 1934 | ·073 | ·35 | ·09 | ·54 | ·01 | ·06 | 3·1 | 31·7 | 1·81 | Grass, mainly brown, short. |
| | | Aug., 1934 | ·042 | ·30 | ·07 | ·09 | trace | ·01 | 2·8 | 39·5 | 1·12 | Grass, brown, short. |
| | | Nov., 1934 | ·14 | ·33 | ·11 | 1·23 | trace | ·24 | 7·8 | 36·3 | 2·88 | Grass, green, leafy. |
| | | Feb., 1935 | ·066 | ·28 | ·07 | ·93 | trace | ·17 | 4·5 | 37·5 | 2·10 | Grass, mainly green, leafy. |
| | | May, 1935 | ·068 | ·29 | ·12 | ·25 | ·01 | ·08 | 3·2 | 30·7 | 1·34 | Grass, mainly brown, short. |
| | | Aug., 1935 | ·059 | ·28 | ·09 | ·30 | trace | ·07 | 2·9 | 38·4 | 1·40 | Grass, brown, leafy. |
| Rusthoek, P.O. Volksrust | Wakkerstroom. | Dec., 1933 | ·20 | ·27 | ·13 | 1·64 | ·05 | ·32 | 8·1 | 34·6 | 3·39 | Grass, mainly green. |
| | | Mar., 1934 | ·094 | ·55 | ·17 | ·99 | ·01 | ·15 | 7·9 | 34·8 | 3·11 | Grass, mainly green short and bush; mostly grass. |
| | | June, 1934 | ·061 | ·37 | ·09 | ·18 | trace | ·03 | 5·0 | 33·3 | 1·66 | Grass, brown, leafy. |
| | | Sept., 1934 | ·069 | ·37 | ·08 | ·09 | ·01 | ·02 | 4·4 | 35·5 | 1·53 | Grass, brown, leafy. |
| | | Dec., 1934 | ·15 | ·32 | ·11 | 1·34 | trace | ·24 | 7·7 | 35·8 | 2·74 | Grass, green, leafy. |
| | | Mar., 1935 | ·093 | ·39 | ·09 | ·79 | trace | ·06 | 6·4 | 33·7 | 2·48 | Grass, green, leafy. |
| | | June, 1935 | ·072 | ·39 | ·10 | ·23 | trace | ·05 | 3·3 | 35·0 | 1·79 | Grass, mainly brown, short. |
| | | Sept., 1935 | ·039 | ·42 | ·06 | ·10 | trace | ·03 | 2·7 | 34·8 | 1·70 | Grass, brown, leafy. |
| Rooiwal, P.O. Paardekop | Standerton..... | Jan., 1934 | ·16 | ·41 | ·15 | 1·48 | ·07 | ·24 | 10·2 | 31·6 | 3·15 | Grass, mainly green, short. |
| | | April, 1934 | ·061 | ·35 | ·15 | ·61 | ·02 | ·09 | 4·2 | 32·4 | 1·50 | Grass, mainly brown, short. |
| | | July, 1934 | ·042 | ·31 | ·08 | ·15 | trace | ·03 | 3·3 | 33·0 | 1·41 | Grass, brown, leafy. |
| | | Oct., 1934 | ·057 | ·29 | ·09 | ·30 | ·01 | ·04 | 6·8 | 32·2 | 1·80 | Grass, leafy. |
| | | Jan., 1935 | ·085 | ·27 | ·13 | ·88 | ·02 | ·13 | 5·8 | 34·3 | 2·05 | Grass, mainly green, leafy. |
| | | April, 1935 | ·13 | ·39 | ·12 | ·81 | ·02 | ·93 | 6·3 | 34·7 | 2·38 | Grass, green, short. |
| | | July, 1935 | ·054 | ·36 | ·10 | ·18 | ·03 | ·05 | 3·2 | 35·3 | 1·74 | Grass, brown, leafy. |
| | | Oct., 1935 | ·046 | ·35 | ·05 | ·12 | ·02 | ·02 | 3·5 | 37·7 | 1·85 | Grass, brown, leafy. |
| Hamelfontein No. 210 | Standerton..... | Nov., 1933 | ·24 | ·27 | ·14 | 2·26 | ·05 | ·44 | 13·9 | 34·9 | 4·42 | Grass, green. |
| | | Feb., 1934 | ·16 | ·31 | ·15 | 1·99 | ·02 | ·38 | 11·0 | 34·8 | 4·55 | Grass, mainly green. |
| | | June, 1934 | ·048 | ·17 | ·04 | ·01 | ·01 | ·02 | — | 40·1 | 0·63 | Grass, brown. |
| | | Sept., 1934 | ·041 | ·24 | ·04 | ·06 | trace | ·17 | 2·8 | 39·8 | 1·06 | Grass, brown, leafy. |
| | | Dec., 1934 | ·20 | ·24 | ·11 | 1·66 | ·04 | ·16 | 7·8 | 38·0 | 3·15 | Grass, mainly green. |
| | | Mar., 1935 | ·082 | ·30 | ·09 | ·97 | ·02 | ·22 | 6·0 | 34·9 | 2·49 | Grass. |
| | | June, 1935 | ·12 | ·31 | ·06 | ·41 | trace | ·07 | 3·2 | 39·2 | 1·55 | Grass, mainly brown, leafy. |
| | | Oct., 1935 | ·075 | ·20 | ·09 | ·48 | ·03 | ·05 | 4·6 | 38·2 | 1·50 | Grass, brown, leafy. |

## AREA 7 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kromdraai No. 16 | Standerton..... | Dec., 1933 | ·13 | ·21 | ·09 | 1·34 | ·05 | ·29 | 5·7 | 31·7 | 2·77 | Grass. |
| | | Mar., 1934 | ·075 | ·22 | ·11 | 1·07 | ·04 | ·21 | 4·1 | 38·9 | 2·03 | Grass, mainly brown. |
| | | Aug., 1934 | ·034 | ·26 | ·08 | ·10 | trace | ·02 | 2·9 | 35·4 | 1·10 | Grass, brown, leafy. |
| | | Nov., 1934 | ·12 | ·24 | ·09 | ·93 | trace | ·34 | 7·5 | 38·1 | 2·08 | Grass, leafy. |
| | | Feb., 1935 | ·12 | ·36 | ·09 | ·71 | ·03 | ·14 | 4·6 | 39·5 | 2·17 | Grass, mainly green, long. |
| | | May, 1935 | ·036 | ·17 | ·07 | ·11 | trace | ·03 | 2·3 | 41·1 | ·86 | Grass, brown. |
| | | Sept., 1935 | ·057 | ·28 | ·09 | ·19 | ·02 | ·02 | 3·7 | 38·5 | 1·62 | Grass, brown, leafy. |
| Rooikoppen...... | Standerton..... | Jan., 1934 | ·13 | ·19 | ·13 | 1·49 | ·04 | ·30 | 8·0 | 36·4 | 2·65 | Grass, mainly green. |
| | | April, 1934 | ·10 | ·25 | ·10 | ·91 | ·03 | ·16 | 3·6 | 33·5 | 1·92 | Grass. |
| | | May, 1934 | ·052 | ·25 | ·08 | ·36 | ·02 | ·08 | 1·9 | 41·0 | 1·44 | Grass, mainly brown. |
| | | July, 1934 | ·052 | ·31 | ·16 | ·65 | ·01 | ·08 | 3·7 | 39·1 | 2·08 | Grass, brown, leafy. |
| | | Oct., 1934 | — | ·22 | ·12 | ·50 | ·02 | — | 4·0 | 37·7 | 1·71 | Grass, brown, leafy. |
| | | Jan., 1935 | ·14 | ·24 | ·15 | 1·85 | ·05 | ·39 | 6·0 | 36·2 | 3·56 | Grass, mainly green, long. |
| | | April, 1935 | ·20 | ·30 | ·14 | ·78 | ·03 | ·11 | 4·4 | 34·6 | 2·39 | Grass, mainly green, long. |
| | | Aug., 1935 | ·069 | ·30 | ·11 | ·33 | ·02 | ·06 | 2·2 | 35·8 | 1·59 | Grass, brown, long. |
| Weltevrede, P.O. Greylingstad | Standerton..... | Dec., 1933 | ·18 | ·20 | ·11 | 1·63 | ·02 | ·20 | 8·9 | 37·0 | 3·41 | Grass, mainly green. |
| | | Mar., 1934 | ·048 | ·17 | ·08 | 1·00 | ·01 | ·16 | 4·3 | 42·5 | 1·94 | Grass, long. |
| | | April, 1935 | ·052 | ·34 | ·09 | ·31 | ·03 | ·06 | 3·9 | 29·8 | 2·68 | Grass. |
| Vogelstruisfontein, | Standerton..... | Jan., 1934 | ·25 | ·38 | ·19 | 2·59 | ·04 | ·64 | 10·1 | 29·3 | 6·36 | Grass, mainly green, leafy. |
| | | May, 1934 | ·034 | ·28 | ·11 | ·55 | trace | ·09 | 3·5 | 39·8 | 1·55 | Grass, mainly brown, long. |
| | | May, 1935 | ·088 | ·33 | ·10 | ·45 | ·03 | ·06 | 3·7 | 35·0 | 1·70 | Grass, brown, leafy. |
| Grootrietvlei, P.O. Dirkiesdorp | Wakkerstroom.. | Mar., 1935 | ·094 | ·30 | ·17 | ·81 | trace | ·13 | 4·6 | 35·7 | 2·33 | Grass, mainly green. |
| | | July, 1935 | ·082 | ·22 | ·09 | ·68 | ·03 | ·12 | 2·9 | 39·8 | 1·71 | Grass, brown. |
| | | Oct., 1935 | ·049 | ·31 | ·09 | ·28 | ·03 | ·07 | 4·2 | 33·6 | 1·64 | Grass, mainly brown. |
| Pypklipberg...... | Ermelo......... | Dec., 1933 | ·17 | ·59 | ·54 | 1·90 | ·11 | ·48 | 10·2 | 32·3 | 5·40 | Grass, mainly green and bush; mostly grass. |
| | | May, 1934 | ·089 | ·42 | ·17 | ·97 | ·02 | ·49 | 4·3 | 36·8 | 2·64 | Grass and bush; mostly grass. |
| | | July, 1934 | ·034 | ·47 | ·11 | ·32 | trace | ·08 | 2·8 | 39·1 | 1·87 | Grass, mainly brown and bush; mostly grass. |
| | | Nov., 1934 | ·095 | ·34 | ·19 | ·98 | ·05 | ·26 | 4·4 | 36·9 | 2·48 | Grass, mainly green and bush; mostly grass. |
| | | Feb., 1935 | ·15 | ·47 | ·26 | 1·72 | ·05 | ·62 | 6·8 | 37·2 | 3·98 | Grass, mainly green and bush; mostly grass. |
| | | May, 1935 | ·094 | ·92 | ·37 | ·97 | ·20 | ·29 | 4·8 | 31·1 | 4·37 | Grass, mainly green. |
| | | Aug., 1935 | ·042 | ·40 | ·15 | ·19 | trace | ·08 | 2·3 | 44·7 | 1·55 | Grass, mainly brown and bush; mostly grass. |

AREA 7 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Commetjie, P.O. Volksrust | Wakkerstroom.. | Feb., 1934 | ·10 | ·36 | ·17 | 1·32 | ·07 | ·36 | 5·9 | 36·0 | 3·12 | Grass, mainly green and bush mostly grass. |
| | | June, 1934 | ·061 | ·27 | ·14 | ·55 | ·02 | ·14 | 4·5 | 38·9 | 1·62 | Grass, mainly brown. |
| | | Sept., 1934 | ·050 | ·51 | ·12 | ·46 | ·03 | ·12 | 4·4 | 38·0 | 1·66 | Grass, mainly brown. |
| | | Dec., 1934 | ·092 | ·51 | ·24 | 1·58 | ·08 | ·57 | 6·2 | 38·6 | 3·90 | Grass, mainly green and bush; mostly grass. |
| | | Mar., 1935 | ·091 | ·34 | ·16 | ·62 | ·11 | ·21 | 4·2 | 37·6 | 2·14 | Grass, mainly green, long. |
| | | June, 1935 | ·053 | ·51 | ·25 | ·45 | ·03 | ·31 | 3·1 | 38·0 | 2·54 | Grass, mainly brown. |
| Confidence....... | Ermelo........ | April, 1934 | ·15 | ·29 | ·13 | 1·26 | ·05 | ·33 | 5·3 | 39·6 | 2·64 | Grass, long. |
| | | Aug., 1934 | ·054 | ·25 | ·16 | ·26 | ·02 | ·06 | 3·5 | 38·2 | 1·32 | Grass, mainly brown. |
| | | Nov., 1934 | ·077 | ·29 | ·10 | ·98 | ·07 | ·31 | 4·6 | 41·8 | 2·35 | Grass, mainly green, long. |
| | | Jan., 1935 | ·10 | ·41 | ·16 | ·89 | ·12 | ·21 | 7·7 | 34·1 | 2·93 | Grass, mainly green, short. |
| | | April, 1935 | ·087 | ·57 | ·27 | 1·21 | ·03 | ·22 | 4·7 | 38·4 | 2·77 | Grass, mainly green, long. |
| | | July, 1935 | ·053 | ·24 | ·09 | ·53 | ·02 | ·13 | 2·4 | 41·4 | 1·41 | Grass, long. |
| | | Sept., 1935 | ·055 | ·17 | ·10 | ·78 | ·06 | ·37 | 4·0 | 39·6 | 1·98 | Grass, mainly brown, long. |
| Vergenoegdheid... | Ermelo........ | Dec., 1933 | ·099 | ·21 | ·19 | ·72 | ·41 | ·37 | 6·9 | 37·7 | 2·74 | Grass, mainly brown. |
| | | Mar., 1934 | ·086 | ·72 | ·38 | 1·15 | ·16 | ·28 | 7·2 | 33·5 | 3·99 | Grass and bush; mostly grass. |
| | | May, 1934 | ·11 | — | ·20 | 1·17 | ·09 | ·63 | 7·9 | 34·7 | 3·01 | Grass, mainly green. |
| | | Aug., 1934 | ·083 | ·28 | ·20 | ·75 | ·12 | ·33 | 5·3 | 37·7 | 2·38 | Grass, mainly brown. |
| | | Nov., 1934 | ·15 | ·30 | ·21 | 1·80 | ·08 | ·56 | 12·6 | 33·4 | 3·87 | Grass, green. |
| | | Feb., 1935 | ·19 | ·37 | ·32 | 2·76 | ·03 | ·55 | 11·6 | 32·9 | 5·38 | Grass, green. |
| | | May, 1935 | ·072 | ·26 | ·14 | ·41 | ·03 | ·09 | 4·3 | 36·7 | 1·80 | Grass, mainly brown. |
| | | Aug., 1935 | ·064 | ·25 | ·14 | ·51 | ·04 | ·15 | 4·4 | 37·7 | 2·18 | Grass, mainly brown. |
| Orangedal........ | Ermelo........ | Jan., 1934 | ·16 | ·26 | ·30 | 1·61 | ·13 | ·34 | 9·5 | 37·1 | 3·43 | Grass, mainly green. |
| | | June, 1934 | ·11 | ·31 | ·25 | 1·34 | ·13 | ·44 | 7·4 | 35·8 | 3·43 | Grass. |
| | | Dec., 1934 | ·22 | ·35 | ·29 | 2·21 | ·06 | ·54 | 11·8 | 36·2 | 4·86 | Grass, green. |
| | | Mar., 1935 | ·097 | ·36 | ·27 | 1·78 | ·03 | ·38 | 6·6 | 39·8 | 3·90 | Grass. |
| | | June, 1935 | ·11 | ·32 | ·21 | ·66 | ·01 | ·12 | 5·1 | 37·1 | 2·32 | Grass, leafy. |
| | | Sept., 1935 | ·091 | ·26 | ·16 | ·74 | ·04 | ·26 | 5·4 | 42·8 | 2·23 | Grass, mainly green. |
| Welkom, P.O. Mahamba | Zwasiland...... | Feb., 1934 | ·14 | ·36 | ·27 | 1·74 | ·11 | ·58 | 6·4 | 34·4 | 3·93 | Grass, mainly green. |
| | | April, 1934 | ·12 | ·32 | ·21 | 1·30 | ·12 | ·68 | 6·9 | 34·9 | 3·08 | Grass, mainly green. |
| | | July, 1934 | ·061 | ·30 | ·17 | ·67 | ·04 | ·18 | 4·3 | 38·0 | 2·04 | Grass, mainly brown, long. |
| | | Oct., 1934 | ·14 | ·25 | ·23 | 1·43 | ·27 | ·76 | 8·6 | 37·0 | 4·04 | Grass, mainly green. |
| | | Jan., 1935 | ·14 | ·29 | ·32 | 2·29 | ·07 | ·54 | 10·7 | 35·8 | 4·70 | Grass, green. |
| | | April, 1935 | ·079 | ·45 | ·30 | 1·38 | ·08 | ·37 | 6·2 | 34·0 | 3·77 | Grass. |
| | | Oct., 1935 | ·056 | ·21 | ·19 | ·84 | ·07 | ·29 | 5·4 | 41·5 | 2·49 | Grass. |
| Nooitgedacht No. 10 | Ermelo........ | Nov.' 1933 | ·12 | ·26 | ·11 | 1·16 | ·01 | ·29 | 7·9 | 35·6 | 3·34 | Grass, mainly green. |
| | | July, 1934 | ·036 | ·29 | ·09 | ·14 | trace | ·03 | 2·7 | 35·9 | 1·40 | Grass, brown, leafy. |
| | | Oct., 1934 | ·052 | ·23 | ·08 | ·26 | ·02 | ·05 | 3·5 | 38·2 | 1·32 | Grass, mainly brown, leafy. |

## AREA 7 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Witbank No. 99.. | Ermelo........ | Aug., 1934 | ·036 | ·28 | ·12 | ·19 | ·01 | ·03 | 3·4 | 38·2 | 1·43 | Grass, brown, leafy. |
| | | Dec., 1934 | ·12 | ·23 | ·09 | 1·25 | ·04 | ·19 | 8·5 | 36·3 | 2·60 | Grass, leafy. |
| | | Mar., 1935 | ·069 | ·44 | ·08 | ·57 | trace | ·09 | 3·7 | 32·8 | 2·12 | Grass, mainly green, leafy. |
| | | June, 1935 | ·062 | ·35 | ·10 | ·32 | trace | ·08 | 2·9 | 34·4 | 1·70 | Grass, brown, leafy. |
| | | Oct., 1935 | ·083 | ·48 | ·16 | ·24 | ·01 | ·04 | 3·4 | 32·9 | 2·22 | Grass, brown, leafy. |
| Merriekloof, P.O. Amsterdam | Ermelo........ | Nov., 1933 | ·062 | ·10 | ·07 | ·77 | ·02 | ·15 | 6·0 | 35·8 | 2·10 | Grass, mainly green. |
| | | Feb., 1934 | ·092 | ·15 | ·12 | 1·52 | ·02 | ·30 | 5·1 | 39·3 | 2·69 | Grass, mainly green. |
| | | May, 1934 | ·032 | ·57 | ·17 | ·57 | ·01 | ·13 | 2·5 | 36·8 | 1·86 | Grass, mainly brown. |
| | | Aug., 1934 | ·044 | ·23 | ·12 | ·20 | trace | ·02 | 4·0 | 44·0 | 1·17 | Grass, brown. |
| | | Nov., 1934 | ·11 | ·29 | ·14 | 1·55 | trace | ·27 | 8·9 | 32·3 | 3·19 | Grass, green, short. |
| | | Feb., 1935 | ·11 | ·17 | ·06 | 1·66 | trace | ·36 | 6·3 | 38·2 | 2·95 | Grass, green. |
| | | May, 1935 | ·06 | ·17 | ·09 | 1·08 | ·05 | ·20 | 4·4 | 40·2 | 2·11 | Grass, mainly green, long. |
| | | Sept., 1935 | ·041 | ·15 | ·07 | ·27 | ·05 | ·06 | 3·1 | 43·5 | 1·30 | Grass, brown, long. |
| The Chime, P.O. Amsterdam | Ermelo........ | Dec,. 1933 | ·12 | ·17 | ·13 | 1·97 | ·03 | ·39 | 9·2 | 42·0 | 3·87 | Grass, mainly green. |
| | | Mar., 1934 | ·11 | ·22 | ·11 | 1·08 | ·02 | ·17 | 4·4 | 41·5 | 2·15 | Grass, mainly green, long. |
| | | June, 1934 | ·053 | ·18 | ·10 | ·62 | ·02 | ·11 | 4·3 | 38·5 | 1·80 | Grass, mainly brown. |
| | | Sept., 1934 | ·034 | ·19 | ·10 | ·11 | trace | ·03 | 2·8 | 39·9 | 1·09 | Grass, mainly brown. |
| | | April, 1935 | ·053 | ·18 | ·10 | ·77 | ·03 | ·17 | 3·8 | 36·1 | 1·73 | Grass, mainly green, long. |
| | | July, 1935 | ·052 | ·18 | ·10 | ·33 | trace | ·10 | 2·6 | 40·0 | 1·61 | Grass, brown, long. |
| | | Aug., 1935 | ·074 | ·30 | ·08 | ·35 | ·02 | ·08 | 3·8 | 40·6 | 2·04 | Grass, brown, leafy. |
| Stafford.......... | Ermelo........ | Jan., 1934 | ·10 | ·18 | ·13 | 1·50 | trace | ·24 | 5·9 | 43·7 | 3·37 | Grass, mainly green. |
| | | April, 1934 | ·079 | ·16 | ·14 | 1·28 | ·04 | ·22 | 5·7 | 37·6 | 2·17 | Grass, mainly green. |
| | | July, 1934 | ·029 | ·16 | ·09 | ·44 | trace | ·10 | 3·3 | 41·9 | 1·20 | Grass, brown. |
| | | Oct., 1934 | ·062 | ·14 | ·07 | ·55 | ·01 | ·13 | 5·4 | 37·6 | 1·54 | Grass, mainly green. |
| | | Jan., 1935 | ·084 | ·20 | ·16 | 1·51 | trace | ·25 | 6·7 | 35·8 | 2·70 | Grass, green. |
| | | June, 1935 | ·038 | ·16 | ·08 | ·42 | trace | ·05 | 2·3 | 41·4 | 1·12 | Grass, brown. |
| | | Oct., 1935 | ·057 | ·11 | ·04 | ·31 | trace | ·04 | 4·8 | 40·4 | 1·14 | Grass, mainly brown. |
| Ndhlorudwalile, P.O. Amsterdam | Ermelo........ | Nov., 1933 | ·063 | ·15 | ·06 | ·55 | ·02 | ·17 | 6·2 | 37·5 | 2·34 | Grass, mainly green. |
| | | Feb., 1934 | ·11 | ·21 | ·15 | 1·22 | trace | ·27 | 6·8 | 36·8 | 2·56 | Grass, mainly green, short. |
| | | May, 1934 | ·044 | ·16 | ·11 | ·68 | ·01 | ·13 | 3·5 | 35·3 | 1·55 | Grass, mainly brown, short. |
| | | Aug., 1934 | ·033 | ·23 | ·12 | ·11 | trace | ·01 | 2·7 | 34·4 | 1·13 | Grass, brown, leafy. |
| | | Nov., 1934 | ·11 | ·22 | ·14 | 1·39 | trace | ·31 | 8·7 | 35·1 | 2·82 | Grass, green, short. |
| Amsterdam (Town) | Ermelo........ | Dec., 1933 | ·10 | ·31 | ·15 | 1·25 | ·04 | ·33 | 8·0 | 35·6 | 3·29 | Grass, mainly green. |
| | | Mar., 1934 | ·083 | ·40 | ·16 | 1·16 | ·02 | ·26 | 7·1 | 35·5 | 3·11 | Grass, mainly green, short. |
| | | June, 1934 | ·041 | ·49 | ·11 | ·47 | ·02 | ·14 | 2·8 | 34·1 | 2·01 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·064 | ·35 | ·09 | ·40 | trace | ·09 | 5·0 | 36·2 | 2·01 | Grass, mainly brown, leafy. |
| | | Dec., 1934 | ·098 | ·48 | ·13 | 1·24 | ·09 | ·36 | 7·0 | 35·1 | 3·05 | Grass, green, short. |
| | | Feb., 1935 | ·082 | ·25 | ·14 | 1·01 | trace | ·15 | 4·8 | 35·6 | 2·47 | Grass, mainly green, short. |
| | | May, 1935 | ·06 | ·35 | ·18 | ·61 | trace | ·22 | 3·6 | 37·1 | 2·15 | Grass, short. |
| | | Aug., 1935 | ·038 | ·34 | ·09 | ·21 | ·02 | ·08 | 3·2 | 39·2 | 1·85 | Grass, brown, short. |

AREA 7 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Steenbokspruit No. 88, P.O. Bankop | Ermelo........ | Jan., 1934 | ·09 | ·22 | ·12 | 1·36 | ·02 | ·26 | 6·0 | 36·2 | 2·65 | Grass, mainly green. |
| | | April, 1934 | ·059 | ·24 | ·11 | ·73 | trace | ·20 | 5·1 | 33·0 | 2·04 | Grass, short. |
| | | July, 1934 | ·034 | ·25 | ·08 | ·13 | ·01 | ·03 | 2·8 | 36·7 | 1·24 | Grass, brown, leafy. |
| | | Oct., 1934 | ·17 | ·46 | ·21 | 1·53 | ·11 | ·50 | 7·7 | 29·4 | 4·25 | Grass, aminly green and bush. mostly grass. |
| | | Jan., 1935 | ·088 | ·21 | ·15 | 1·18 | ·02 | ·23 | 5·3 | 34·9 | 2·78 | Grass, mainly green, short. |
| | | April, 1935 | ·083 | ·33 | ·16 | ·81 | trace | ·21 | 6·0 | 34·4 | 2·70 | Grass, leafy. |
| | | Oct., 1935 | ·077 | ·41 | ·15 | ·34 | ·08 | ·13 | 5·5 | 34·9 | 2·91 | Grass, brown, short. |
| Hereford No. 223 P.O. The Brook | Ermelo........ | Nov., 1933 | ·095 | ·16 | ·09 | 1·02 | ·02 | ·26 | 6·9 | 32·2 | 2·79 | Grass, mainly brown, short. |
| | | Feb., 1934 | ·096 | ·18 | ·11 | 1·28 | ·02 | ·27 | 8·2 | 39·8 | 2·76 | Grass, mainly green, short. |
| | | May, 1934 | ·045 | ·23 | ·07 | ·68 | ·02 | ·21 | 4·6 | 34·5 | 1·56 | Grass, short. |
| | | Aug., 1934 | ·051 | ·32 | ·09 | ·17 | trace | ·02 | 2·9 | 36·3 | 1·31 | Grass, mainly brown. |
| | | Nov., 1934 | ·10 | ·17 | ·12 | 1·42 | trace | ·36 | 10·0 | 32·4 | 2·74 | Grass, green, short. |
| Meadow Bank, P.O. The Brook | Ermelo........ | Dec., 1933 | ·11 | ·16 | ·13 | 1·77 | ·04 | ·58 | 9·5 | 34·9 | 3·91 | Grass, short. |
| | | Mar., 1934 | ·10 | ·25 | ·13 | 1·23 | ·32 | ·40 | 6·9 | 33·8 | 3·22 | Grass, mainly green, short. |
| | | June, 1934 | ·034 | ·14 | ·07 | ·27 | ·01 | ·07 | 3·3 | 36·5 | 1·36 | Grass, mainly brown, short. |
| | | Sept., 1934 | ·10 | ·11 | ·09 | 1·18 | ·03 | ·27 | 8·0 | — | 2·37 | Grass, mainly green, short. |
| | | Dec., 1934 | ·13 | ·20 | ·11 | 1·82 | ·05 | ·38 | 10·4 | 30·7 | 2·98 | Grass, green, short. |
| Waverley, P.O. The Brook | Ermelo........ | Mar., 1934 | ·091 | ·27 | ·15 | 1·19 | ·02 | ·23 | 6·0 | 36·5 | 2·65 | Grass, mainly green, short. |
| | | April, 1934 | ·11 | ·27 | ·13 | 1·15 | ·04 | ·22 | 4·8 | 38·9 | 2·45 | Grass, short. |
| | | July, 1934 | ·045 | ·30 | ·13 | ·39 | trace | ·04 | 2·9 | 38·8 | 1·76 | Grass, brown, leafy. |
| | | Oct., 1934 | ·078 | ·27 | ·10 | ·68 | ·03 | ·14 | 5·0 | 32·1 | 1·71 | Grass, mainly green, leafy. |
| Simonsdal No.162, P.O. Lake Chrissie | Ermelo........ | Nov., 1933 | ·24 | ·25 | ·09 | 2·10 | ·01 | ·41 | 10·2 | 33·0 | 4·17 | Grass, mainly green. |
| | | Feb., 1934 | ·10 | ·24 | ·13 | 1·00 | ·09 | ·51 | 7·0 | 33·9 | 3 04 | Grass, mainly green. |
| Grasdal, P.O. Lake Chrissie | Ermelo........ | Dec., 1933 | ·11 | ·27 | ·15 | 1·78 | ·04 | ·40 | 8·5 | 35·9 | 3·78 | Grass, mainly green and bush. |
| | | Mar., 1934 | ·069 | ·28 | ·14 | ·95 | ·02 | ·27 | 5·6 | 32·6 | 2·26 | Grass, mainly green. |
| Fernie Hough No. 189 | Ermelo........ | Jan., 1934 | ·11 | ·17 | ·12 | 1·71 | ·05 | ·43 | 7·8 | 35·6 | 3·18 | Grass, mainly green. |
| | | April, 1934 | ·14 | ·36 | ·14 | ·91 | ·04 | ·28 | 4·4 | 33·3 | 2·19 | Grass, leafy. |
| Houtbos, P.O. Oshoek | Ermelo........ | Nov., 1933 | ·13 | ·17 | ·12 | 1·31 | ·05 | ·35 | 9·9 | 33·9 | 3·34 | Grass, mainly green. |
| | | Feb., 1934 | ·10 | ·35 | ·17 | 1·44 | ·13 | ·44 | 5·9 | 35·1 | 3·50 | Grass, mainly green. |
| Nakensvlei....... | Belfast........ | Nov., 1933 | ·22 | ·37 | ·19 | 2·35 | ·04 | ·50 | 14·9 | 27·4 | 5·30 | Grass, green. |
| | | Feb., 1934 | ·09 | ·34 | ·30 | 1·59 | ·02 | ·50 | 9·1 | 33·3 | 3·75 | Grass, mainly green. |
| | | May, 1934 | ·039 | ·39 | ·16 | ·55 | ·01 | ·16 | 5·3 | 36·1 | 1·99 | Grass, leafy and bush; mostly grass. |
| | | Nov., 1934 | ·16 | ·31 | ·20 | 1·54 | ·04 | ·55 | 9·6 | 35·1 | 4·16 | Grass, green, long. |
| | | Feb., 1935 | ·094 | ·23 | ·11 | ·97 | ·03 | ·24 | 6·0 | 34·2 | 2·19 | Grass, green. |
| | | May, 1935 | ·064 | ·27 | ·16 | ·47 | trace | ·09 | 3·7 | 32·8 | 1·81 | Grass, leafy. |
| | | Aug., 1935 | ·055 | ·29 | ·12 | ·24 | trace | ·11 | 3·3 | 35·3 | 1·64 | Grass, brown, leafy. |

## AREA 7 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steynsplaas**...... | **Belfast**........ | Dec., 1933 | ·20 | ·25 | ·16 | 2·26 | ·03 | ·52 | 10·2 | 36·2 | 5·02 | Grass, mainly green. |
| | | Mar., 1934 | ·15 | ·32 | ·15 | 1·42 | ·02 | ·35 | 7·7 | 34·0 | 3·15 | Grass, mainly green. |
| | | June, 1934 | ·05 | ·26 | ·12 | ·35 | ·01 | ·05 | 3·6 | 36·4 | 1·62 | Grass, mainly brown, leafy. |
| | | Dec., 1934 | ·15 | ·27 | ·15 | 1·93 | ·04 | ·39 | 10·8 | 34·9 | 4·24 | Grass, mainly green. |
| | | Mar., 1935 | ·10 | ·28 | ·14 | 1·01 | ·08 | ·24 | 6·4 | 34·9 | 2·54 | Grass, mainly green, leafy. |
| | | June, 1935 | ·088 | ·39 | ·15 | ·46 | ·02 | ·16 | 3·3 | 36·6 | 2·09 | Grass, mainly brown leafy. |
| | | Sept., 1935 | ·034 | ·33 | ·11 | ·15 | ·06 | ·04 | 3·0 | 37·0 | 1·71 | Grass, brown, leafy. |
| **Volstruispoort**.... | **Belfast**........ | Jan., 1934 | ·11 | ·34 | ·23 | 1·65 | ·05 | ·50 | 9·1 | 33·3 | 4·18 | Grass, green and bush; mostly grass. |
| | | April, 1934 | ·081 | ·41 | ·29 | 1·40 | trace | ·32 | 4·1 | 34·3 | 3·35 | Grass, mainly green, short and bush; mostly grass. |
| | | July, 1934 | ·048 | ·27 | ·10 | ·31 | ·01 | ·03 | 3·6 | 35·4 | 1·43 | Grass, mainly brown, leafy. |
| | | Jan., 1935 | ·094 | ·32 | ·24 | 1·28 | ·03 | ·45 | 7·8 | 34·8 | 3·65 | Grass, green, short. |
| | | April, 1935 | ·074 | ·23 | ·13 | ·68 | ·02 | ·15 | 3·9 | 34·1 | 2·16 | Grass, mainly green, leafy. |
| | | July, 1935 | ·052 | ·28 | ·10 | ·19 | ·01 | ·07 | 3·4 | 38·4 | 1·56 | Grass, brown, leafy and bush; mostly grass. |
| | | Oct., 1935 | ·033 | ·20 | ·03 | ·18 | trace | ·02 | 4·0 | 30·0 | 1·48 | Grass, brown, leafy. |
| **Paardeplaats**..... | Carolina....... | Nov., 1933 | ·19 | ·19 | ·13 | 1·75 | ·07 | ·40 | 12·2 | 32·2 | 3·65 | Green, green, leafy. |
| | | Feb., 1934 | ·10 | ·25 | ·14 | 1·27 | ·05 | ·23 | 7·5 | 31·2 | 2·78 | Grass, mainly green, short. |
| | | May, 1934 | ·058 | ·24 | ·14 | ·62 | ·01 | ·13 | 5·8 | 30·2 | 2·06 | Grass, mainly brown, short. |
| | | Aug., 1934 | ·040 | ·20 | ·09 | ·12 | trace | ·03 | 3·7 | 31·8 | 1·14 | Grass, brown, short. |
| | | Nov., 1934 | ·17 | ·20 | ·14 | 1·68 | trace | ·23 | 11·5 | 32·0 | 3·17 | Grass, green, short. |
| | | Feb., 1935 | ·12 | ·22 | ·08 | 1·12 | trace | ·18 | 7·0 | 31·0 | 2·30 | Grass, green, short. |
| **Buffelspruit, p/b Hillside Store** | Carolina....... | Dec., 1933 | ·13 | ·40 | ·16 | 2·10 | ·05 | ·46 | 10·5 | 32·0 | 4·07 | Grass, green. |
| | | Mar., 1934 | ·12 | ·39 | ·14 | 1·17 | ·02 | ·29 | 8·0 | 27·8 | 3·01 | Grass, mainly green, short. |
| | | June, 1934 | ·052 | ·31 | ·08 | ·32 | trace | ·04 | 3·3 | 33·4 | 1·50 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·19 | ·37 | ·16 | 1·98 | ·07 | ·38 | 11·7 | 28·2 | 3·67 | Grass, green, short. |
| | | Dec., 1934 | ·11 | ·38 | ·12 | 1·36 | trace | ·24 | 8·2 | 33·3 | 2·96 | Grass, green, leafy. |
| | | Mar., 1935 | ·094 | ·34 | ·10 | ·76 | trace | ·17 | 5·6 | 36·7 | 2·18 | Grass, green, leafy. |
| **Kranspan**........ | Carolina....... | Jan., 1934 | ·16 | ·31 | ·17 | 1·28 | ·01 | ·19 | 8·3 | 35·4 | 3·19 | Grass, green, leafy. |
| | | April, 1934 | ·087 | ·41 | ·19 | ·63 | ·02 | ·14 | 5·8 | 29·9 | 2·59 | Grass, mainly green, short. |
| | | July, 1934 | ·061 | ·28 | ·12 | ·16 | trace | ·03 | 3·3 | 31·4 | 1·28 | Grass, brown, leafy. |
| | | Oct., 1934 | ·12 | ·30 | ·14 | 1·27 | ·03 | ·22 | 8·0 | 29·2 | 2·86 | Grass, green, short. |
| | | Jan., 1935 | ·11 | ·20 | ·15 | 1·45 | ·03 | ·32 | 7·7 | 36·2 | 2·66 | Grass, green, short. |
| | | April, 1935 | ·088 | ·30 | ·14 | ·53 | trace | ·09 | 5·0 | 30·3 | 2·14 | Grass, mainly green, short. |
| **Doornhoek No. 241, P.O. Waterval Boven** | Carolina....... | Nov., 1933 | ·18 | ·31 | ·16 | 1·56 | ·04 | ·35 | 11·5 | 35·4 | 3·40 | Grass, green, leafy. |
| | | Feb., 1934 | ·15 | ·23 | ·16 | 1·13 | ·20 | ·14 | 5·2 | 36·4 | 2·45 | Grass, mainly green. |
| | | May, 1934 | ·041 | ·24 | ·12 | ·37 | ·01 | ·06 | 2·6 | 37·5 | 1·33 | Grass, mainly brown, long. |
| | | Aug., 1934 | ·062 | ·28 | ·14 | ·28 | ·01 | ·03 | 2·8 | 37·8 | 1·46 | Grass, mainly brown. |
| | | Nov., 1934 | ·084 | ·22 | ·09 | ·55 | trace | ·13 | 4·0 | 38·0 | 1·56 | Grass, mainly green. |
| | | Sept., 1935 | ·069 | ·24 | ·04 | ·26 | ·02 | ·02 | 2·5 | 41·3 | 1·19 | Grass, brown. |

AREA 7 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Van Wykavlei No. 96 | Carolina....... | Dec., 1933 | ·10 | ·24 | ·15 | 1·30 | ·04 | ·27 | 8·2 | 35·3 | 2·57 | Grass. |
| | | Mar., 1934 | ·11 | ·25 | ·13 | 1·09 | ·02 | ·29 | 6·0 | 35·0 | 2·38 | Grass, mainly green. |
| | | June‘ 1934 | ·029 | ·21 | ·08 | ·17 | ·01 | ·03 | 4·9 | 35·9 | 1·24 | Grass, brown, leafy. |
| | | Sept., 1934 | ·054 | ·25 | ·08 | ·24 | ·02 | ·03 | 5·7 | 35·3 | 1·26 | Grass, mainly brown. |
| | | Dec., 1934 | ·10 | ·25 | ·15 | 1·27 | ·07 | ·34 | 8·1 | 31·5 | 2·53 | Grass, green. |
| | | Mar., 1935 | ·089 | ·23 | ·10 | ·85 | ·02 | ·15 | 5·5 | 35·3 | 1·90 | Grass, mainly green, leafy. |
| | | Aug., 1935 | ·036 | ·27 | ·13 | ·28 | ·04 | ·07 | 2·9 | 37·0 | 1·51 | Grass, brown, leafy. |
| Weltevrede No. 254, Via Hendrina | Carolina....... | Jan., 1934 | ·14 | ·23 | ·19 | 1·74 | ·03 | ·31 | 7·9 | 39·7 | 3·62 | Grass. |
| | | April, 1934 | ·083 | ·31 | ·20 | 1·13 | ·03 | ·25 | 6·5 | 35·2 | 2·88 | Grass. |
| | | July, 1934 | ·030 | ·20 | ·10 | ·30 | ·01 | ·03 | 3·2 | 37·5 | 1·39 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·077 | ·19 | ·09 | ·57 | trace | ·13 | 5·2 | 34·7 | 1·39 | Grass, green, long. |
| | | Jan., 1935 | ·14 | ·22 | ·21 | 2·36 | ·05 | ·43 | 9·5 | 35·9 | 4·32 | Grass, green, leafy. |
| | | April, 1935 | ·032 | ·28 | ·16 | ·73 | ·02 | ·15 | 4·0 | 31·3 | 1·97 | Grass, long. |
| | | July, 1935 | ·064 | ·27 | ·14 | ·38 | ·02 | ·10 | — | 35·6 | 1·60 | Grass, brown, leafy. |
| | | Oct., 1935 | ·066 | ·26 | ·10 | ·21 | ·02 | ·02 | 3·9 | 38·2 | 1·54 | Grass, brown, leafy. |
| Heuweltop....... | Nelspruit...... | Nov., 1933 | ·11 | ·31 | ·14 | 1·66 | ·03 | ·39 | 9·9 | 31·0 | 3·41 | Grass, green, short. |
| | | Feb., 1934 | ·095 | ·25 | ·17 | 1·30 | ·03 | ·42 | 6·8 | 32·8 | 2·81 | Grass, mainly green, short. |
| | | May, 1934 | ·085 | ·38 | ·18 | ·88 | ·02 | ·22 | 5·0 | 33·7 | 2·82 | Grass, mainly brown, short. |
| | | Aug., 1934 | ·086 | ·26 | ·12 | ·60 | ·03 | ·17 | 3·9 | 36·0 | 1·92 | Grass, mainly browr. |
| The Rest........ | Nelspruit...... | Dec., 1933 | ·13 | ·32 | ·20 | 1·76 | ·04 | ·50 | — | 31·7 | 3·98 | Grass, mainly green, short. |
| | | Mar., 1934 | ·096 | ·25 | ·16 | 1·19 | ·04 | ·31 | 6·7 | 33·9 | 2·97 | Grass, mainly green, short. |
| | | June, 1934 | ·051 | ·25 | ·12 | ·55 | ·02 | ·21 | 3·7 | 37·1 | 1·93 | Grass, mainly brown, short. |
| | | Oct., 1934 | ·055 | ·21 | ·13 | ·36 | ·02 | ·14 | 3·5 | 37·5 | 1·69 | Grass, short. |
| | | June, 1935 | ·071 | ·23 | ·09 | ·66 | trace | ·09 | 3·0 | 43·9 | 1·74 | Grass, mainly brown. |
| | | Oct., 1935 | ·084 | ·26 | ·08 | 1·03 | ·05 | ·27 | 5·8 | 43·8 | 2·39 | Grass, mainly green. |
| Cromdale No. 82. | Nelspruit...... | Jan.. 1934 | ·11 | ·33 | ·18 | 1·31 | ·10 | ·38 | 6·1 | 32·8 | 3·03 | Grass, mainly green, short. |
| | | April, 1934 | ·073 | ·31 | ·14 | ·89 | ·02 | ·25 | 4·6 | 35·8 | 2·38 | Grass, short. |
| | | July, 1934 | ·057 | ·30 | ·11 | ·29 | trace | ·07 | 4·0 | 37·0 | 1·58 | Grass, mainly brown. |
| | | Sept.. 1934 | ·058 | ·28 | ·09 | ·27 | ·02 | ·21 | 4·4 | 36·5 | 1·50 | Grass, mainly brown, short. |
| | | June, 1935 | ·09 | ·28 | ·16 | 1·39 | trace | ·44 | 4·8 | 36·7 | 3·67 | Grass. |
| | | Sept., 1935 | ·097 | ·33 | ·16 | ·69 | ·13 | ·26 | 5·0 | 37·4 | 2·20 | Grass, mainly brown. |
| White River..... | Nelspruit...... | Feb., 1934 | ·12 | ·27 | ·15 | 1·86 | ·05 | ·41 | 7·2 | 39·0 | 4·05 | Grass and bush; mostly grass. |
| | | May, 1934 | ·048 | ·22 | ·13 | ·88 | ·02 | ·23 | 3·7 | 40·3 | 2·03 | Grass, mainly brown. |
| | | Aug., 1934 | ·032 | ·26 | ·16 | ·26 | ·01 | ·04 | 3·2 | 39·2 | 1·44 | Grass, mainly brown. |
| | | Nov., 1934 | ·08 | ·23 | ·16 | ·98 | ·04 | ·23 | 6·0 | 35·7 | 2·47 | Grass, mainly green, leafy. |
| | | Feb., 1935 | ·10 | ·25 | ·20 | 1·59 | ·04 | ·31 | 5·7 | 37·6 | 3·28 | Grass, mainly green, leafy. |
| | | May, 1935 | ·04 | ·24 | ·13 | ·30 | ·01 | ·07 | 2·8 | 35·6 | 1·55 | Grass, brown, leafy. |
| | | July, 1935 | ·059 | ·25 | ·07 | ·27 | ·02 | ·10 | 2·6 | 40·6 | 1·32 | Grass, mainly brown, leafy. |

## AREA 7 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Koekemoersrust, P.O. White River | Nelspruit...... | Dec., 1933 | ·18 | ·36 | ·17 | 2·29 | ·04 | ·46 | 10·8 | 33·4 | 5·26 | Grass, mainly green. |
| | | Mar., 1934 | ·10 | ·39 | ·18 | 1·23 | ·03 | ·22 | 7·1 | 37·2 | 3·26 | Grass and bush; mostly grass. |
| | | June, 1934 | ·069 | ·25 | ·10 | ·49 | trace | ·12 | 3·1 | 37·1 | 1·80 | Grass, mainly brown. |
| | | Sept., 1934 | ·068 | ·29 | ·16 | ·68 | trace | ·12 | 4·8 | 38·2 | 2·10 | Grass, mainly brown. |
| | | Dec., 1934 | ·13 | ·36 | ·17 | 2·15 | ·05 | ·66 | 8·1 | 34·4 | 5·30 | Grass, mainly green, leafy. |
| | | Mar., 1935 | ·095 | ·43 | ·14 | ·88 | trace | ·21 | 4·5 | 35·8 | 2·95 | Grass, mainly green, leafy. |
| | | June, 1935 | ·078 | ·23 | ·12 | ·70 | ·03 | ·26 | 3·5 | 40·9 | 2·14 | Grass. |
| | | Sept., 1935 | ·052 | ·21 | ·13 | ·52 | ·04 | ·22 | 3·5 | 38·6 | 1·85 | Grass, brown, short. |
| Sukkel, P.O. White River | Nelspruit...... | Jan., 1934 | ·16 | ·38 | ·17 | 1·74 | ·08 | ·48 | 7·3 | 37·8 | 4·33 | Grass, mainly green and bush; mostly grass. |
| | | April, 1934 | ·065 | ·32 | ·16 | ·71 | ·03 | ·20 | 4·7 | 39·8 | 2·05 | Grass and bush; mostly grass. |
| | | July, 1934 | ·049 | ·54 | ·14 | ·61 | trace | ·15 | 3·6 | 38·6 | 2·52 | Grass, mainly brown and bush; mostly grass. |
| | | Oct., 1934 | ·055 | ·38 | ·13 | ·51 | ·02 | ·07 | 4·2 | 43·7 | 1·86 | Grass, mainly brown and bush. |
| | | Jan., 1935 | ·11 | ·21 | ·13 | 1·55 | ·04 | ·35 | 6·2 | 37·5 | 3·06 | Grass, mainly green. |
| | | April, 1935 | ·077 | ·41 | ·18 | ·57 | ·05 | ·22 | 5·1 | 33·4 | 2·51 | Grass, leafy. |
| | | Aug., 1935 | ·057 | ·30 | ·14 | ·53 | trace | ·13 | 2·6 | 42·7 | 1·61 | Grass, brown. |
| Mara, P.O. Krokodilpoort | Nelspruit...... | Jan., 1935 | ·16 | ·24 | ·11 | ·91 | ·04 | ·21 | 4·2 | 43·2 | 2·21 | Grass, mainly green. |
| | | April, 1935 | ·081 | ·28 | ·11 | ·74 | ·02 | ·13 | 3·3 | 37·4 | 1·92 | Grass. |
| | | July, 1935 | ·097 | ·47 | ·14 | ·80 | ·11 | ·27 | 4·8 | 38·6 | 2·62 | Grass, leafy. |
| | | Oct., 1935 | ·069 | ·32 | ·11 | ·35 | ·03 | ·06 | 3·5 | 39·9 | 1·63 | Grass, brown, leafy. |
| Eerstegeluk...... | Nelspruit...... | Sept., 1934 | ·094 | ·27 | ·11 | ·71 | ·06 | ·20 | 6·1 | 35·3 | 2·59 | Grass. |
| | | Dec., 1934 | ·11 | ·26 | ·15 | 2·18 | ·04 | ·45 | 8·2 | 37·3 | 3·83 | Grass, mainly green, leafy. |
| | | Mar., 1935 | ·089 | ·40 | ·15 | 1·04 | ·03 | ·17 | 5·9 | 38·1 | 2·61 | Grass, mainly green. |
| | | June, 1935 | ·10 | ·44 | ·14 | ·44 | trace | ·15 | 3·4 | 35·9 | 1·93 | Grass, mainly green, leafy. |
| | | Sept., 1935 | ·064 | ·38 | ·17 | ·48 | ·05 | ·20 | 4·5 | 36·4 | 1·91 | Grass, brown, leafy. |
| Peebles, P·O. White River | Nelspruit...... | Dec., 1933 | ·11 | ·22 | ·17 | 1·75 | ·03 | ·38 | 8·7 | 33·7 | 3·78 | Grass, mainly green. |
| | | Mar., 1934 | ·074 | ·24 | ·24 | ·73 | ·03 | ·22 | 5·6 | 39·6 | 2·25 | Grass, mainly green. |
| | | June, 1934 | ·047 | ·26 | ·07 | — | ·01 | ·06 | 4·2 | 35·8 | 1·62 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·060 | ·41 | ·12 | ·47 | ·02 | ·15 | 5·3 | 34·9 | 1·53 | Grass, mainly brown, leafy. |
| | | Dec., 1934 | ·13 | ·24 | ·15 | 1·57 | ·04 | ·32 | 7·8 | 36·1 | 3·11 | Grass, mainly green, leafy. |
| | | Mar., 1935 | — | ·25 | ·15 | ·90 | trace | — | 5·9 | 35·4 | 4·71 | Grass, green, leafy. |
| | | July, 1935 | ·065 | ·27 | ·15 | ·38 | ·03 | ·10 | 3·9 | 36·0 | 1·50 | Grass, leafy. |
| | | Oct., 1935 | ·070 | ·26 | ·09 | ·38 | ·02 | ·07 | 4·7 | 36·1 | 1·82 | Grass, mainly brown, leafy. |
| De Rust, P.O. White River | Nelspruit...... | Jan., 1934 | ·12 | ·29 | ·13 | 1·69 | ·22 | ·43 | 6·8 | 41·9 | 3·65 | Grass, mainly green. |
| | | April, 1934 | ·10 | ·36 | ·51 | 1·08 | trace | ·25 | 6·8 | 36·8 | 2·63 | Grass, mainly green, leafy. |
| | | July, 1934 | ·05 | ·45 | ·11 | ·45 | ·02 | ·07 | 3·8 | 34·9 | 1·89 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·058 | ·32 | ·10 | ·32 | ·02 | ·12 | 4·2 | 33·7 | 1·50 | Grass, leafy. |
| | | Feb., 1935 | ·11 | ·28 | ·13 | 1·14 | ·05 | ·27 | 5·9 | 34·1 | 2·71 | Grass, green, leafy. |
| | | May, 1935 | ·12 | ·38 | ·25 | 1·11 | ·02 | ·26 | 7·7 | 33·0 | 3·01 | Grass, mainly green, leafy. |
| | | Aug., 1935 | ·078 | ·36 | ·15 | ·44 | ·02 | ·12 | 3·4 | 38·3 | 1·70 | Grass, brown, leafy. |

## AREA 7 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hampton, P.O. White River | Nelspruit...... | Feb., 1934 | ·13 | ·22 | ·18 | 1·25 | ·02 | ·29 | 5·9 | 36·5 | 2·70 | Grass, mainly green. |
| | | May, 1934 | ·043 | ·28 | ·24 | ·50 | ·02 | ·15 | 3·4 | 36·2 | 1·86 | Grass, leafy. |
| | | Aug., 1934 | ·049 | ·28 | ·11 | ·23 | trace | ·03 | 2·9 | 36·6 | 1·39 | Grass, mainly brown, leafy. |
| | | Nov., 1934 | ·20 | ·27 | ·19 | 2·14 | trace | ·46 | 10·7 | 32·8 | 4·15 | Grass, green, leafy. |
| | | Jan., 1935 | ·11 | ·25 | ·19 | 1·46 | trace | ·33 | 6·5 | 34·7 | 2·86 | Grass, green. |
| | | April, 1935 | ·077 | ·36 | ·14 | ·69 | ·03 | ·15 | 4·3 | 33·5 | 2·29 | Grass, mainly green, leafy. |
| | | June, 1935 | ·056 | ·28 | ·13 | ·34 | trace | ·07 | 3·0 | 39·7 | 1·59 | Grass, mainly brown, leafy. |
| | | Sept., 1935 | ·047 | ·49 | ·17 | ·28 | ·07 | ·16 | 3·6 | 37·8 | 2·13 | Grass, brown, leafy. |
| Schagen No. 134. | Nelspruit...... | Jan., 1934 | ·19 | ·23 | ·17 | 1·71 | ·04 | ·39 | 11·9 | 37·9 | 3·96 | Grass, mainly green. |
| | | June, 1934 | ·085 | ·39 | ·20 | ·66 | ·01 | ·11 | 4·3 | 36·4 | 2·58 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·068 | ·58 | ·15 | ·51 | ·02 | ·07 | 5·3 | 38·3 | 2·08 | Grass, mainly brown. |
| | | Feb., 1935 | ·13 | ·24 | ·14 | 1·53 | ·04 | ·23 | 5·4 | 34·8 | 2·99 | Grass, mainly green. |
| | | May, 1935 | ·11 | ·32 | ·19 | 1·65 | trace | ·28 | 4·7 | 36·9 | 2·93 | Grass, mainly green. |
| | | Aug., 1935 | ·084 | ·34 | ·19 | ·65 | trace | ·15 | 3·6 | 44·5 | 2·22 | Grass, brown. |
| Rooiwal No. 132. P.O. Brondal | Nelspruit...... | May, 1934 | ·05 | ·23 | ·11 | 1·03 | ·03 | ·22 | 3·8 | 39·6 | 2·40 | Grass. |
| | | Aug., 1934 | ·06 | ·27 | ·14 | ·34 | trace | ·04 | 3·4 | 38·1 | 1·44 | Grass, mainly brown. |
| | | Nov., 1934 | ·10 | ·19 | ·13 | 1·49 | trace | ·31 | 7·0 | 37·3 | 2·85 | Grass, green. |
| | | Jan., 1935 | ·088 | ·24 | ·16 | 1·61 | ·06 | ·36 | 5·4 | 37·8 | 3·28 | Grass, mainly green. |
| | | April, 1935 | ·12 | ·32 | ·18 | 1·25 | ·04 | ·29 | 5·4 | 36·9 | 3·11 | Grass, mainly green. |
| | | July, 1935 | ·053 | ·40 | ·18 | ·64 | ·02 | ·11 | 4·5 | 35·3 | 2·23 | Grass, mainly brown. |
| | | Oct., 1935 | ·10 | ·41 | ·15 | 1·12 | ·21 | ·28 | 6·7 | 35·6 | 3·19 | Grass, mainly brown, leafy. |
| Friedenheim...... | Nelspruit...... | July, 1934 | ·051 | ·32 | ·10 | ·54 | ·01 | ·09 | 3·6 | 37·7 | 1·66 | Grass, mainly brown. |
| | | Oct., 1934 | ·054 | ·24 | ·09 | ·31 | ·03 | ·08 | 3·6 | 40·7 | 1·50 | Grass, brown. |
| | | Mar., 1935 | ·15 | ·34 | ·19 | 1·38 | ·07 | ·45 | 5·1 | 38·6 | 3·46 | Grass, mainly green, leafy. |
| Grootgeluk No. 116 P.O. Godwan River | Nelspruit...... | Dec., 1933 | ·15 | ·34 | ·16 | 1·76 | ·03 | ·45 | 7·4 | 34·1 | 3·54 | Grass, mainly green. |
| | | April, 1934 | ·15 | ·27 | ·14 | 1·14 | ·02 | ·39 | 4·8 | 35·7 | 2·77 | Grass. |
| | | Aug., 1934 | ·058 | ·25 | ·16 | ·34 | trace | ·07 | 3·3 | 35·6 | 1·58 | Grass, brown, short. |
| | | Sept., 1934 | ·13 | ·22 | ·11 | ·85 | ·02 | — | 6·8 | 34·7 | 2·31 | Grass, short. |
| | | April, 1935 | ·089 | ·28 | ·17 | ·58 | ·04 | ·18 | 4·0 | 37·2 | 2·20 | Grass, mainly brown, short. |
| | | July, 1935 | ·12 | ·34 | ·11 | ·64 | ·01 | ·16 | 3·4 | 39·0 | 1·94 | Grass, brown, short. |
| | | Oct., 1935 | — | ·39 | ·20 | ·63 | ·21 | — | 5·1 | 34·4 | 3·00 | Grass, mainly brown, short. |
| Lindenau, P.O. Elandshoek | Nelspruit...... | Mar., 1934 | ·096 | ·27 | ·14 | ·90 | ·02 | ·20 | 5·7 | 34·4 | 2·13 | Grass, mainly green, short. |
| | | June, 1934 | ·052 | ·27 | ·22 | ·85 | ·02 | ·28 | 3·7 | 33·0 | 2·68 | Grass, mainly brown, short. |
| | | Dec., 1934 | ·092 | ·34 | ·26 | ·98 | ·09 | ·43 | 6·1 | 34·6 | 3·95 | Grass, short. |
| | | June, 1935 | ·075 | ·27 | ·14 | ·43 | trace | ·13 | 3·5 | 38·9 | 2·22 | Grass, mainly brown, short. |
| | | Sept., 1935 | ·073 | ·42 | ·17 | ·34 | ·06 | ·14 | 4·3 | 38·9 | 2·88 | Grass, brown, short. |

### AREA 7 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rietspruit No. 37, P.O. Airlie | Carolina....... | July, 1934 | ·040 | ·24 | ·12 | ·32 | trace | ·05 | 2·8 | 40·3 | 1·54 | Grass, mainly brown, short. |
| | | Nov., 1934 | ·098 | ·28 | ·20 | ·98 | ·04 | ·37 | 7·9 | 32·3 | 3·01 | Grass, mainly green, short. |
| | | Feb., 1935 | ·14 | ·26 | ·19 | ·74 | ·03 | ·33 | 4·6 | 31·8 | 3·12 | Grass, short. |
| | | May, 1935 | ·10 | ·27 | ·16 | ·87 | ·05 | ·25 | 4·6 | 33·0 | 2·87 | Grass, short. |
| | | Aug., 1935 | ·11 | ·40 | ·21 | ·55 | ·32 | ·32 | 4·5 | 35·3 | 3·17 | Grass, brown, short. |
| Middleham, P.O. Kaapschehoop | Nelspruit...... | Feb., 1934 | ·32 | ·72 | ·44 | 2·71 | ·05 | ·51 | 10·4 | 28·6 | 8·80 | Bush. |
| | | April, 1934 | ·24 | ·59 | ·36 | 2·82 | ·04 | ·63 | 11·6 | 31·7 | 6·72 | Grass, mainly green and bush; mostly grass. |
| | | July, 1934 | — | ·26 | ·06 | ·34 | ·01 | — | 2·5 | 38·0 | 1·31 | Grass, brown. |
| | | June, 1935 | ·081 | ·29 | ·16 | ·82 | ·03 | ·19 | 5·3 | 46·0 | 2·22 | Grass, long. |
| | | Sept., 1935 | ·12 | ·46 | ·27 | ·84 | ·16 | ·46 | 6·1 | 32·6 | 3·25 | Grass, mainly green, short. |
| Bellevue, P.O. Entre Nous | Baberton...... | Jan., 1934 | ·15 | ·45 | ·28 | 1·94 | ·03 | ·53 | 11·5 | 40·5 | 5·27 | Grass and bush. |
| | | May, 1934 | ·053 | ·17 | ·15 | ·58 | ·01 | ·10 | 2·1 | 42·1 | 1·31 | Grass, mainly brown, long. |
| | | Aug., 1934 | ·098 | ·21 | ·11 | ·23 | ·02 | ·02 | 2·1 | 41·2 | 1·27 | Grass, brown, long. |
| | | Jan., 1935 | ·087 | ·23 | ·12 | 1·11 | ·03 | ·26 | 5·2 | 39·4 | 2·27 | Grass, green, long. |
| | | Mar., 1935 | ·10 | ·23 | ·12 | ·60 | trace | ·10 | 3·2 | 41·2 | 1·71 | Grass, long. |
| | | May, 1935 | ·086 | ·36 | ·23 | ·85 | ·11 | ·55 | 4·6 | 32·4 | 2·78 | Grass, mainly green, leafy. |
| | | Sept., 1935 | ·065 | ·24 | ·12 | ·42 | ·06 | ·64 | 3·5 | 37·2 | 1·78 | Grass, brown, short. |

## AREA 8.

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goedehoop....... | Christiana...... | Nov., 1933 | ·042 | ·49 | ·10 | ·20 | ·29 | ·03 | 3·4 | 34·6 | 2·15 | Grass, brown. |
| | | Feb., 1934 | ·16 | ·29 | ·08 | ·90 | ·38 | ·18 | 7·7 | 34·3 | 2·82 | Grass, mainly green. |
| | | May, 1934 | ·084 | — | ·11 | ·66 | ·03 | ·18 | 2·9 | 38·9 | 1·53 | Grass, mainly brown. |
| | | Aug., 1934 | ·070 | ·32 | ·07 | ·41 | ·01 | ·04 | 3·9 | 37·9 | 1·62 | Grass, brown. |
| | | Nov., 1934 | ·10 | ·26 | ·067 | ·81 | trace | ·15 | 6·0 | 39·1 | 2·04 | Grass, green. |
| | | Feb., 1935 | ·12 | ·41 | ·17 | 1·69 | ·04 | ·49 | 7·8 | 36·0 | 3·77 | Grass, mainly green. |
| | | May, 1935 | ·13 | ·57 | ·17 | 1·05 | trace | ·16 | 7·4 | 32·7 | 2·82 | Grass, green, short. |
| | | Aug., 1935 | ·076 | ·63 | ·15 | ·32 | ·02 | ·09 | 4·8 | 36·8 | 2·52 | Grass, brown, leafy. |
| Skoonreg........ | Christiana...... | Dec., 1933 | ·14 | ·27 | ·17 | 2·09 | ·03 | ·55 | 9·8 | 30·3 | 4·67 | Grass, short. |
| | | Mar., 1934 | ·13 | ·40 | ·16 | 1·99 | trace | ·58 | 11·8 | 30·4 | 4·05 | Grass, mainly green. |
| | | June, 1934 | ·078 | ·29 | ·11 | 1·00 | ·03 | ·27 | 5·9 | 35·5 | 2·93 | Grass, mainly brown. |
| | | Sept., 1934 | ·062 | ·22 | ·12 | ·55 | ·03 | ·15 | 4·7 | 35·3 | 2·10 | Grass, brown. |
| | | Dec., 1934 | ·094 | ·56 | ·11 | 1·31 | ·23 | ·28 | 7·0 | 33·9 | 3·38 | Grass, mainly green. |
| | | Mar., 1935 | ·088 | ·51 | ·10 | 1·10 | ·06 | ·24 | 6·3 | 31·7 | 3·27 | Grass, mainly green, short. |
| | | June, 1935 | ·054 | ·62 | ·09 | ·29 | trace | ·05 | 3·6 | 34·3 | 2·13 | Grass, brown, short. |
| | | Sept., 1935 | ·058 | ·54 | ·09 | ·46 | ·02 | ·13 | 5·1 | 34·3 | 2·49 | Grass, brown, leafy. |
| Richmond, P.O. Britten | Christiana...... | Jan., 1934 | ·22 | ·33 | ·12 | 2·10 | ·18 | ·44 | 10·1 | 33·3 | 4·49 | Grass, mainly green. |
| | | April, 1934 | ·15 | ·44 | ·12 | 1·38 | ·04 | ·22 | 8·3 | 32·2 | 3·02 | Grass, mainly green. |
| | | July, 1934 | ·049 | ·31 | ·06 | ·26 | ·01 | ·02 | 6·6 | 36·5 | 1·44 | Grass, brown. |
| | | Oct., 1934 | ·064 | ·38 | ·08 | ·28 | trace | ·03 | 3·6 | 35·0 | 1·51 | Grass, brown. |
| | | Jan., 1935 | ·079 | ·26 | ·09 | 1·12 | ·02 | ·26 | 5·6 | 32·1 | 2·22 | Grass, mainly green, long. |
| | | April, 1935 | ·10 | ·39 | ·11 | 1·05 | ·02 | ·20 | 6·4 | 32·5 | 2·72 | Grass, mainly green. |
| | | July, 1935 | ·081 | ·50 | ·11 | ·37 | ·03 | ·09 | 4·4 | 35·9 | 2·16 | Grass, brown, leafy. |
| | | Oct., 1935 | ·094 | ·44 | ·14 | 1·00 | ·09 | ·21 | 8·1 | 29·0 | 2·99 | Grass, leafy. |
| Appeldraai... ... | Ventersdorp.... | Feb., 1934 | ·10 | ·32 | ·23 | 1·40 | ·04 | ·28 | 6·9 | 33·2 | 3·16 | Grass, mainly green. |
| | | May, 1934 | ·064 | ·46 | ·15 | ·68 | trace | ·16 | 3·3 | 33·8 | 2·13 | Grass, mainly brown, leafy. |
| | | Aug., 1934 | ·051 | ·35 | ·12 | ·16 | trace | ·01 | 2·6 | 35·7 | 1·52 | Grass, brown, leafy.. |
| | | Nov. 1934 | ·096 | ·29 | ·12 | ·76 | trace | ·37 | 6·1 | 35·7 | 2·24 | Grass, mainly green, leafy. |
| | | Feb., 1935 | ·083 | ·54 | ·15 | 1·80 | trace | ·28 | 5·7 | 34·4 | 2·80 | Grass, green, leafy. |
| | | May, 1935 | ·076 | ·45 | ·11 | ·44 | trace | ·08 | 4·0 | 32·2 | 1·86 | Grass, mainly green, short. |
| | | Aug., 1935 | ·065 | ·32 | ·12 | ·36 | trace | ·08 | 2·4 | 34·1 | 1·84 | Grass, brown, leafy. |
| Vlakfontein...... | Ventersdorp.... | Dec., 1933 | ·16 | ·25 | ·12 | 1·60 | trace | ·32 | — | 37·6 | 3·54 | Grass, mainly green. |
| | | Mar., 1934 | ·13 | ·29 | ·17 | 1·44 | ·02 | ·27 | 4·9 | 37·3 | 2·89 | Grass. |
| | | June, 1934 | ·061 | ·35 | ·15 | ·32 | trace | ·05 | 3·2 | 34·6 | 1·70 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·037 | ·29 | ·14 | ·09 | ·02 | ·04 | 3·3 | 34·3 | 1·27 | Grass, brown, leafy. |
| | | Dec., 1934 | ·085 | ·28 | ·18 | 1·04 | ·08 | ·18 | 6·1 | 32·6 | 2·57 | Grass, leafy. |
| | | April, 1935 | ·085 | ·32 | ·12 | ·73 | ·02 | ·11 | 5·6 | 36·0 | 2·58 | Grass, green, leafy. |
| | | June, 1935 | ·060 | ·32 | ·08 | ·25 | trace | ·05 | 2·9 | 38·7 | 1·51 | Grass, brown, leafy. |
| | | Sept., 1935 | ·040 | ·24 | ·16 | ·24 | ·01 | ·08 | 2·9 | 35·2 | 1·97 | Grass, brown, leafy. |

## AREA 8 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Doornpan........ | Ventersdorp.... | Jan., 1934 | ·12 | ·25 | ·12 | 1·56 | trace | ·23 | 10·7 | 39·0 | 3·70 | Grass, mainly green. |
| | | April, 1934 | ·10 | ·39 | ·16 | ·66 | ·03 | ·15 | 4·9 | 35·0 | 2·02 | Grass. |
| | | July, 1934 | ·061 | ·33 | ·12 | ·26 | trace | ·07 | 2·7 | 34·0 | 1·65 | Grass. brown, leafy. |
| | | Oct., 1934 | ·069 | ·32 | ·16 | ·36 | trace | ·07 | 3·9 | 36·1 | 1·81 | Grass, brown, leafy. |
| | | Jan., 1935 | ·11 | ·37 | ·12 | 1·31 | trace | ·47 | 7·1 | 33·2 | 3·04 | Grass, mainly green, leafy. |
| | | Mar., 1935 | ·075 | ·30 | ·11 | ·78 | trace | ·13 | 5·5 | 33·0 | 2·15 | Grass, leafy. |
| | | July, 1935 | ·081 | ·47 | ·17 | ·38 | ·03 | ·10 | 3·1 | 35·6 | 3·03 | Grass, brown, leafy. |
| | | Oct., 1935 | ·067 | ·30 | ·07 | ·27 | trace | ·04 | 3·9 | 35·4 | 1·69 | Grass, brown, leafy. |
| Doornhoek No. 24 | Klerksdorp..... | Nov., 1933 | ·075 | ·22 | ·12 | ·44 | trace | ·13 | 3·7 | 33·2 | 2·21 | Grass, mainly brown. |
| | | Feb., 1934 | ·13 | ·27 | ·20 | 1·89 | ·03 | ·43 | 10·0 | 35·3 | 3·98 | Grass, mainly green. |
| | | May, 1934 | ·068 | ·34 | ·19 | 1·35 | ·04 | ·34 | 5·1 | 33·4 | 2·95 | Grass, leafy. |
| | | Aug., 1934 | ·048 | ·29 | ·13 | ·32 | trace | ·04 | 3·6 | 35·3 | 2·07 | Grass, brown, leafy. |
| | | Nov., 1934 | ·12 | ·35 | ·18 | 1·90 | trace | ·34 | 8·7 | 35·7 | 3·57 | Grass, mainly green, leafy. |
| | | Feb., 1935 | ·11 | ·38 | ·27 | 2·20 | trace | ·63 | 8·8 | 35·3 | 4·51 | Grass, green, leafy. |
| | | May, 1935 | ·072 | ·34 | ·13 | ·52 | trace | ·10 | 4·7 | 30·4 | 1·94 | Grass, leafy. |
| | | Aug., 1935 | ·063 | ·36 | ·15 | ·38 | ·05 | ·09 | 2·8 | 35·2 | 2·05 | Grass, brown, leafy. |
| Lapfontein, P.O. Brakspruit | Klerksdorp..... | Dec., 1933 | ·18 | ·37 | ·24 | 2·27 | ·03 | ·54 | 14·3 | 31·1 | 4·75 | Grass, mainly green, short. |
| | | Mar., 1934 | ·14 | ·36 | ·16 | 1·81 | ·03 | ·38 | 6·5 | 37·7 | 3·78 | Grass, mainly green. |
| | | June, 1934 | ·10 | ·50 | ·18 | ·87 | ·01 | ·21 | 4·1 | 36·1 | 2·87 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·07 | ·37 | ·09 | ·32 | trace | ·05 | 4·2 | 36·9 | 1·77 | Grass, brown, leafy. |
| | | Jan., 1935 | ·096 | ·51 | ·25 | 2·29 | trace | ·49 | 8·3 | 34·9 | 4·78 | Grass, green, short. |
| | | Mar., 1935 | ·17 | ·45 | ·13 | 1·52 | trace | ·30 | 10·7 | 33·3 | 3·35 | Grass, green, leafy. |
| | | June, 1935 | ·08 | ·49 | ·08 | ·64 | trace | ·07 | 4·9 | 32·3 | 2·21 | Grass, brown, leafy. |
| | | Sept., 1935 | ·061 | ·34 | ·10 | ·38 | ·04 | ·13 | 4·1 | 33·5 | 1·88 | Grass, brown, leafy. |
| Swartkoppies No. 59 | Klerksdorp..... | Feb., 1934 | ·14 | ·26 | ·15 | 2·19 | ·04 | ·56 | 8·9 | 36·4 | 4·82 | Grass, mainly green, leafy. |
| | | April, 1934 | ·11 | ·31 | ·13 | 1·49 | ·14 | ·42 | 7·6 | 31·3 | 2·90 | Grass, mainly green, leafy. |
| | | July, 1934 | ·054 | ·48 | ·14 | ·39 | trace | ·15 | 3·8 | 35·4 | 2·00 | Grass, brown, leafy. |
| | | Oct., 1934 | ·13 | ·36 | ·10 | ·63 | ·02 | ·09 | 4·6 | 33·7 | 2·19 | Grass, mainly green, leafy. |
| | | Jan., 1935 | ·11 | ·33 | ·12 | 1·14 | ·03 | ·56 | 5·3 | 32·7 | 2·58 | Grass, mainly green, leafy. |
| | | April, 1935 | ·14 | ·37 | ·14 | 1·12 | ·04 | ·17 | 6·9 | 33·2 | 2·88 | Grass, green, leafy. |
| | | July, 1935 | ·10 | ·51 | ·18 | ·79 | ·01 | ·13 | 4·0 | 37·5 | 2·80 | Grass, brown, leafy. |
| | | Oct., 1935 | ·051 | ·29 | ·05 | ·09 | trace | ·01 | 2·9 | 42·7 | 1·23 | Grass, brown. |
| Driefontein No. 31 | Wolmaransstad. | Nov., 1933 | ·049 | ·15 | ·14 | ·41 | ·16 | ·33 | 5·2 | 41·0 | 1·79 | Grass. |
| | | Feb., 1934 | ·13 | ·19 | ·09 | 1·36 | ·10 | ·30 | 7·2 | 37·9 | 2·87 | Grass, mainly green. |
| | | May, 1934 | ·12 | ·43 | ·17 | 1·12 | ·04 | ·35 | 7·9 | 33·0 | 3·28 | Grass. |
| | | Oct., 1934 | ·066 | ·36 | ·13 | ·39 | trace | ·07 | 4·5 | 33·3 | — | Grass, leafy. |
| | | Jan., 1935 | ·11 | ·29 | ·13 | 1·21 | ·03 | ·32 | 6·9 | 35·3 | 2·69 | Grass, mainly green, leafy. |
| | | April, 1935 | ·078 | ·26 | ·091 | ·70 | trace | ·19 | 5·3 | 35·4 | 3·44 | Grass. |
| | | July, 1935 | ·067 | ·36 | ·12 | ·31 | ·02 | ·07 | 3·3 | 36·1 | 1·91 | Grass, brown, leafy. |
| | | Oct., 1935 | ·055 | ·34 | ·11 | ·29 | trace | ·02 | 3·8 | 32·5 | 1·93 | Grass, brown, leafy. |

AREA 8 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Zwartrand....... | Wolmaransstad. | Dec., 1933 | ·14 | — | ·08 | 1·11 | ·02 | ·21 | 7·1 | 40·4 | 2·38 | Grass, mainly green. |
| | | Mar., 1934 | ·11 | ·20 | ·10 | 1·25 | trace | ·35 | 5·3 | 38·9 | 2·78 | Grass. |
| | | June, 1934 | ·14 | ·31 | ·10 | ·65 | ·03 | ·15 | 4·7 | 37·3 | 2·08 | Grass, mainly brown and bush; mostly grass. |
| | | Aug., 1934 | ·044 | ·37 | ·09 | ·16 | trace | ·01 | 2·8 | 34·5 | 1·52 | Grass, brown, leafy. |
| | | Nov., 1934 | ·077 | ·27 | ·13 | 1·09 | ·15 | ·43 | 5·5 | 39·3 | 2·82 | Grass, mainly brown, leafy. |
| | | Feb., 1935 | ·11 | ·43 | ·19 | ·94 | trace | ·19 | 5·5 | 33·4 | 2·75 | Grass, green, leafy. |
| | | May, 1935 | ·10 | ·32 | ·06 | ·34 | ·02 | ·08 | 4·5 | 32·2 | 1·82 | Grass, mainly brown, leafy. |
| | | Aug., 1935 | ·092 | ·32 | ·11 | ·53 | ·02 | ·17 | 4·7 | 37·0 | 3·28 | Grass, brown, leafy. |
| Oessonskraal, P.O. Maquassi | Wolmaransstad. | Jan., 1934 | ·23 | ·24 | ·13 | 2·41 | ·06 | ·47 | 9·1 | 32·7 | 4·46 | Grass, mainly green. |
| | | April, 1934 | ·092 | ·21 | ·06 | ·45 | ·02 | ·05 | 5·4 | 34·0 | 1·39 | Grass, leafy. |
| | | Oct., 1934 | ·06 | ·31 | ·10 | ·37 | trace | ·09 | 4·4 | 33·6 | 1·57 | Grass, leafy. |
| | | Dec., 1934 | ·084 | ·20 | ·09 | 1·34 | trace | ·24 | 5·4 | 37·1 | 2·54 | Grass, mainly green, leafy. |
| | | Mar., 1935 | ·074 | ·25 | ·12 | ·70 | ·02 | ·12 | 5·1 | 35·7 | 1·88 | Grass. |
| | | June, 1935 | ·053 | ·28 | ·09 | ·34 | trace | ·03 | 4·1 | 38·7 | 1·52 | Grass, brown, leafy. |
| | | Sept., 1935 | ·044 | ·27 | ·09 | ·22 | trace | ·08 | 3·6 | 34·8 | 1·50 | Grass, brown, leafy. |
| Panfontein....... | Schweizer-Reneke | Nov., 1933 | ·13 | ·27 | ·12 | ·98 | ·02 | ·22 | 8·7 | 29·5 | 3·31 | Grass. |
| | | Oct., 1934 | ·063 | ·20 | ·10 | ·48 | trace | ·08 | 5·1 | 35·2 | 1·57 | Grass, brown. |
| | | Jan., 1935 | ·054 | ·17 | ·07 | ·60 | ·02 | ·10 | 4·5 | 35·6 | 1·51 | Grass, mainly green. |
| | | April, 1935 | ·050 | ·21 | ·084 | ·36 | ·02 | ·12 | 4·5 | 35·7 | 1·50 | Grass, mainly green. |
| | | July, 1935 | ·057 | ·28 | ·089 | ·25 | ·02 | ·07 | 3·2 | 34·9 | 1·68 | Grass, brown. |
| Makoukop....... | Schweizer-Reneke | Dec., 1933 | ·071 | ·23 | ·13 | 1·10 | ·06 | ·22 | 6·6 | 42·8 | 3·80 | Grass. |
| | | April, 1934 | ·075 | ·29 | ·10 | ·76 | ·02 | ·17 | 4·7 | 37·5 | 2·00 | Grass. |
| | | June, 1934 | ·049 | ·26 | ·085 | ·62 | trace | ·13 | 4·4 | 34·1 | 1·94 | Grass, mainly brown. |
| | | Aug., 1934 | ·036 | ·20 | ·10 | ·41 | trace | ·04 | 4·3 | 35·8 | 1·39 | Grass, brown. |
| | | Nov., 1934 | ·054 | ·21 | ·088 | ·42 | trace | ·09 | 5·1 | 37·3 | 1·47 | Grass. |
| | | Feb., 1935 | ·065 | ·25 | ·09 | 1·04 | ·02 | ·22 | 6·5 | 33·5 | 2·42 | Grass, mainly green. |
| Holpan.......... | Schweizer-Reneke | Mar., 1934 | ·13 | ·28 | ·18 | 1·63 | ·02 | ·36 | 10·9 | 32·7 | 3·47 | Grass, short. |
| | | May. 1934 | ·093 | ·31 | ·14 | ·93 | ·03 | ·23 | 5·5 | 34·8 | 2·82 | Grass. |
| | | July, 1934 | ·030 | ·22 | ·07 | ·25 | trace | ·05 | 4·0 | 39·5 | 1·30 | Grass, brown. |
| | | Sept., 1934 | ·046 | ·25 | ·10 | ·41 | ·02 | ·06 | 4·4 | 33·6 | 1·40 | Grass, brown. |
| | | Mar., 1935 | ·080 | ·28 | ·09 | ·72 | ·02 | ·16 | 5·1 | 36·1 | 2·10 | Grass, green, short. |
| Vyfhoek......... | Potchefstroom.. | Dec., 1933 | ·21 | ·29 | ·11 | 2·03 | ·02 | ·28 | 12·1 | 26·0 | 5·94 | Grass, green, short. |
| | | Feb., 1934 | ·15 | ·26 | ·14 | 1·46 | ·02 | ·18 | 7·9 | 30·2 | 2·98 | Grass, mainly green, short. |
| | | May, 1934 | ·063 | ·32 | ·13 | ·80 | ·02 | ·10 | 3·7 | 32·2 | 2·20 | Grass, leafy. |
| | | Aug., 1934 | ·051 | ·38 | ·17 | ·24 | ·01 | ·04 | 4·1 | 31·7 | 1·81 | Grass, mainly brown, leafy. |
| | | Feb., 1935 | ·089 | ·27 | ·16 | 1·84 | trace | ·28 | 5·9 | 30·7 | 2·64 | Grass, mainly green, short. |
| | | May, 1935 | ·088 | ·28 | ·11 | ·86 | ·02 | ·17 | 5·8 | 32·8 | 2·22 | Grass, mainly green, leafy. |
| | | Aug., 1935 | ·066 | ·42 | ·13 | ·32 | ·03 | ·05 | 3·5 | 35·0 | 2·18 | Grass, brown, leafy. |

## AREA 8 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Buffelsvlei, P.O. Boskop | Potchefstroom.. | Jan., 1934 | ·14 | ·28 | ·16 | 1·74 | ·02 | ·25 | 14·6 | 31·4 | 3·98 | Grass, mainly green, short. |
| | | Mar., 1934 | ·098 | ·33 | ·16 | 1·09 | ·02 | ·21 | 5·9 | 36·1 | 2·76 | Grass, mainly green. |
| | | June, 1934 | ·05 | ·31 | ·13 | ·44 | ·01 | ·07 | 4·0 | 31·4 | 1·75 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·045 | ·40 | ·11 | ·26 | ·02 | ·04 | 3·6 | 32·4 | 1·80 | Grass, brown, leafy. |
| | | Dec., 1934 | ·14 | ·36 | ·11 | 1·77 | ·45 | ·67 | 10·1 | 28·3 | 4·46 | Grass, green, leafy. |
| | | July, 1935 | ·056 | ·39 | ·11 | ·36 | ·01 | ·11 | 4·3 | 30·7 | 1·97 | Grass, brown, leafy. |
| | | Sept., 1935 | ·040 | ·32 | ·11 | ·23 | ·02 | ·10 | 3·6 | 33·5 | 1·68 | Grass, brown, short. |
| Elbrinsen........ | Potchefstroom.. | Feb., 1934 | ·10 | ·30 | ·17 | 1·92 | ·02 | ·39 | 6·7 | 34·8 | 3·88 | Grass, mainly green. |
| | | April, 1934 | ·089 | ·43 | ·21 | 1·40 | ·04 | ·38 | 7·3 | 34·2 | 3·70 | Grass, mainly green. |
| | | July, 1934 | ·053 | ·34 | ·13 | ·39 | trace | ·08 | 3·6 | 34·7 | 1·98 | Grass, brown, leafy. |
| | | Oct., 1934 | ·091 | ·30 | ·12 | ·56 | ·07 | ·11 | 6·0 | 34·9 | 1·90 | Grass, mainly green, leafy. |
| | | Jan., 1935 | ·13 | ·28 | ·16 | 1·52 | trace | ·27 | 7·3 | 33·5 | 3·31 | Grass, mainly green, leafy. |
| | | June, 1935 | ·12 | ·29 | ·21 | 1·01 | ·02 | ·14 | 5·2 | 37·2 | 2·85 | Grass, brown, leafy. |
| Rietvlei No. 113. | Krugersdorp... | Jan., 1934 | ·078 | ·19 | ·10 | ·98 | trace | ·16 | 6·3 | 40·3 | 2·15 | Grass, mainly green. |
| | | April, 1934 | ·087 | ·23 | ·10 | ·55 | ·01 | ·10 | — | 34·5 | 1·37 | Grass. |
| | | Aug., 1934 | ·031 | ·19 | ·07 | ·13 | trace | ·01 | 2·5 | 34·7 | 1·01 | Grass, brown, leafy. |
| | | Nov., 1934 | ·16 | ·19 | ·12 | 1·26 | ·02 | ·15 | 12·1 | 31·1 | 3·10 | Grass, green, short. |
| | | Feb., 1935 | ·11 | ·19 | ·07 | ·66 | ·03 | ·14 | 5·5 | 34·1 | 2·19 | Grass, green, leafy. |
| | | May 1935 | ·048 | ·20 | ·10 | ·28 | trace | ·07 | 3·4 | 32·6 | 1·57 | Grass, mainly brown, short. |
| | | Aug., 1935 | ·052 | ·29 | ·097 | ·23 | trace | ·09 | 2·9 | 35·2 | 1·61 | Grass, brown, leafy. |
| Danielsrust No. 19 | Krugersdorp... | Feb., 1934 | ·13 | ·27 | ·17 | 1·37 | ·03 | ·32 | 11·1 | 35·2 | 3·23 | Grass, green. |
| | | May, 1934 | ·029 | ·27 | ·17 | ·48 | ·02 | ·10 | 2·9 | 38·1 | 1·67 | Grass, mainly brown, long. |
| | | July, 1934 | ·076 | ·31 | ·10 | — | — | ·08 | 4·4 | 34·1 | 1·77 | Grass, brown, leafy. |
| | | Jan., 1935 | ·070 | ·53 | ·21 | 1·32 | trace | ·18 | 5·7 | 36·0 | 3·37 | Grass, green, leafy. |
| | | April, 1935 | ·10 | ·29 | ·15 | 1·21 | ·03 | ·22 | 5·1 | 36·9 | 3·15 | Grass, mainly green, leafy. |
| | | July, 1935 | ·035 | ·34 | ·16 | ·23 | trace | ·08 | 3·2 | 36·9 | 2·00 | Grass, brown, short. |
| | | Oct., 1935 | ·062 | ·33 | ·13 | ·34 | trace | ·03 | 4·8 | 32·8 | 2·43 | Grass, brown, short. |
| Steenkoppies No. 101, P.O. Magaliesberg | Krugersdorp... | Mar., 1934 | ·084 | ·27 | ·28 | ·83 | ·01 | ·23 | 5·8 | 35·3 | 2·32 | Grass, mainly green. |
| | | July, 1934 | ·029 | ·34 | ·15 | ·18 | ·01 | ·03 | 3·3 | 34·9 | 1·54 | Grass, brown, leafy. |
| | | Sept., 1934 | ·096 | ·19 | ·12 | ·92 | ·02 | ·27 | 7·8 | 33·3 | 2·06 | Grass, short. |
| | | Dec., 1934 | ·10 | ·25 | ·13 | 1·37 | trace | ·29 | 7·2 | 34·6 | 3·03 | Grass, green, leafy. |
| | | Mar., 1935 | ·12 | ·18 | ·12 | ·81 | trace | ·14 | 5·9 | 34·8 | 3·17 | Grass, mainly green, leafy. |
| | | June, 1935 | ·044 | ·25 | ·15 | ·27 | trace | ·09 | 2·5 | 35·9 | 1·71 | Grass, mainly brown, short. |
| | | Sept., 1935 | ·031 | ·30 | ·11 | ·15 | ·02 | ·06 | 2·8 | 36·4 | 1·47 | Grass, brown, short. |
| Loskop P.O. Meyerton | Vereniging..... | Oct., 1933 | ·050 | ·26 | ·06 | ·29 | ·02 | ·02 | 6·2 | 36·4 | 1·45 | Grass, brown. |
| | | Jan., 1934 | ·19 | ·29 | ·09 | 1·75 | ·03 | ·25 | 11·8 | 30·0 | 3·80 | Grass, green, short. |
| | | April, 1934 | ·12 | ·47 | ·16 | ·98 | ·03 | ·23 | 6·2 | 35·2 | 2·48 | Grass, mainly green, leafy. |
| | | Aug., 1934 | ·042 | ·40 | ·10 | ·16 | trace | ·02 | 2·9 | 35·3 | 1·58 | Grass, mainly brown, leafy. |
| | | Mar., 1935 | ·086 | ·36 | ·13 | ·78 | trace | ·09 | 6·0 | 32·3 | 2·35 | Grass, green, short. |
| | | June, 1935 | ·073 | ·30 | ·09 | ·33 | trace | ·06 | 3·2 | 36·4 | 1·67 | Grass, brown, leafy. |
| | | Sept., 1935 | ·041 | ·27 | ·09 | ·14 | ·01 | ·06 | 3·0 | 33·6 | 1·28 | Grass, brown, short. |

AREA 8 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Slangfontein, P.O. Meyerton** | **Vereniging.....** | Nov., 1933 | ·16 | ·31 | ·12 | 1·32 | ·04 | ·24 | 9·8 | 36·7 | 3·53 | Grass. |
| | | Feb., 1934 | ·13 | ·28 | ·12 | 1·49 | trace | ·29 | 9·2 | 30·4 | 3·20 | Grass, mainly green, short. |
| | | May, 1934 | ·056 | ·54 | ·21 | ·75 | ·02 | ·18 | 3·8 | 33·0 | 2·87 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·025 | ·48 | ·08 | ·10 | ·01 | ·02 | 2·9 | 34·6 | 1·50 | Grass, brown, leafy. |
| | | April, 1935 | ·13 | ·34 | ·14 | 1·00 | ·12 | ·16 | 6·7 | 29·3 | 2·76 | Grass, green, short. |
| | | July, 1935 | ·063 | ·37 | ·13 | ·27 | ·02 | ·08 | 3·4 | 41·4 | 1·81 | Grass, brown, leafy. |
| | | Oct., 1935 | ·045 | ·34 | ·06 | ·13 | ·02 | ·01 | 3·3 | 33·0 | 1·56 | Grass, brown, short. |
| **Chrissiefontein, P.O. Meyerton** | **Vereniging.....** | Dec., 1933 | ·14 | ·27 | ·17 | 2·14 | ·02 | ·36 | 10·3 | 30·2 | 3·56 | Grass, green, short. |
| | | Mar., 1934 | ·069 | ·30 | ·26 | ·97 | ·02 | ·27 | 4·1 | 32·4 | 2·49 | Grass, mainly green, short. |
| | | June, 1934 | ·045 | ·29 | ·16 | ·32 | trace | ·05 | 3·7 | 34·9 | 1·42 | Grass, mainly brown, leafy. |
| | | Feb., 1935 | ·082 | ·28 | ·11 | ·75 | ·02 | ·09 | 5·5 | 30·7 | 1·98 | Grass, mainly green, short. |
| | | May, 1935 | ·069 | ·41 | ·14 | ·44 | trace | ·08 | 4·3 | 28·6 | 2·19 | Grass, short. |
| | | Aug., 1935 | ·098 | ·41 | ·15 | ·31 | trace | ·10 | 3·6 | 35·4 | 2·04 | Grass, brown, short. |
| **Heidelberg (Town Lands)** | **Heidelberg.....** | Dec., 1933 | ·065 | ·16 | ·08 | ·93 | ·01 | ·19 | 5·6 | 34·7 | 2·48 | Grass. |
| | | Mar., 1934 | ·062 | ·17 | ·11 | ·63 | ·01 | ·12 | 4·9 | 37·6 | 1·72 | Grass, mainly green. |
| | | June, 1934 | ·062 | ·18 | ·10 | ·22 | trace | ·04 | 3·3 | 36·9 | 1·24 | Grass, mainly brown. |
| | | Sept., 1934 | ·054 | ·22 | ·13 | ·45 | trace | ·07 | 4·7 | 32·2 | 2·02 | Grass, short. |
| | | Jan., 1935 | ·16 | ·30 | ·12 | 1·44 | ·04 | ·27 | 8·2 | 35·5 | 3·30 | Grass, green. |
| | | April, 1935 | ·086 | ·28 | ·14 | ·37 | ·02 | ·09 | 5·2 | 33·6 | 2·34 | Grass. |
| | | July, 1935 | ·037 | ·24 | ·11 | ·31 | ·04 | ·12 | 2·9 | 35·0 | 1·37 | Grass, brown, leafy. |
| | | Oct., 1935 | ·090 | ·22 | ·11 | ·58 | trace | ·01 | 5·9 | 32·3 | 1·80 | Grass, mainly green, short. |
| **Klippoortjie No. 228** | **Heidelberg.....** | Jan., 1934 | ·20 | ·22 | ·15 | 1·83 | ·07 | ·35 | 7·5 | 40·6 | 4·12 | Grass, mainly green. |
| | | April, 1934 | ·083 | ·32 | ·09 | ·83 | ·02 | ·18 | 4·6 | 37·0 | 2·32 | Grass, mainly green. |
| | | July, 1934 | ·048 | ·16 | ·07 | ·25 | trace | ·03 | 3·4 | 40·2 | 1·33 | Grass, brown, long. |
| | | Oct., 1934 | ·052 | ·13 | ·03 | ·30 | trace | ·02 | 4·7 | 34·7 | 1·30 | Grass, mainly brown. |
| | | Feb., 1935 | ·096 | ·29 | ·12 | ·80 | ·08 | ·24 | 5·2 | 34·2 | 2·19 | Grass, mainly green. |
| | | May, 1935 | ·046 | ·16 | ·06 | ·36 | trace | ·08 | 3·8 | 34·6 | 1·56 | Grass, mainly brown, leafy. |
| | | Aug., 1935 | ·058 | ·24 | ·12 | ·36 | trace | ·08 | 2·6 | 25·6 | 1·73 | Grass, brown, short. |
| **Eendracht.......** | **Heidelberg.....** | Feb., 1934 | ·11 | ·19 | ·11 | 1·41 | ·02 | ·35 | 6·7 | 40·0 | 2·83 | Grass, mainly green. |
| | | May, 1934 | ·031 | ·19 | ·07 | ·44 | ·01 | ·18 | 2·5 | 40·2 | 1·53 | Grass, mainly brown. |
| | | Aug., 1934 | ·047 | ·25 | ·10 | ·13 | trace | ·01 | 2·7 | 39·7 | 1·42 | Grass, brown. |
| | | Nov., 1934 | ·083 | ·17 | ·08 | ·84 | ·04 | ·15 | 6·6 | 42·1 | 2·10 | Grass, mainly green, long. |
| | | Mar., 1935 | ·067 | ·53 | ·11 | ·43 | trace | ·07 | 4·1 | 38·4 | 1·65 | Grass, mainly green, leafy. |
| | | June, 1935 | ·084 | ·22 | ·07 | ·32 | trace | ·06 | 4·3 | 37·7 | 1·88 | Grass, brown, leafy. |
| | | Sept., 1935 | ·058 | ·38 | ·14 | ·42 | ·05 | ·08 | 4·6 | 31·3 | 1·95 | Grass, brown, short. |
| **Dealesgift........** | **Bloemfontein...** | Dec., 1933 | ·22 | ·46 | ·28 | 2·31 | ·03 | ·41 | 12·4 | 29·6 | 5·36 | Grass, mainly green, and bush; mostly grass. |
| | | Mar., 1934 | ·12 | ·29 | ·15 | 1·45 | ·03 | ·36 | 7·0 | 40·1 | 3·41 | Grass, mainly green. |
| | | June, 1934 | ·04 | ·38 | ·11 | ·50 | ·01 | ·14 | 3·7 | 38·7 | 1·78 | Grass, mainly brown. |
| | | Sept., 1934 | ·066 | ·25 | ·15 | ·55 | ·01 | ·14 | 4·8 | 35·9 | 1·85 | Grass, mainly brown, leafy, and bush; mostly grass. |
| | | May, 1935 | ·17 | ·31 | ·13 | ·93 | ·03 | ·19 | 5·1 | 35·4 | 2·57 | Grass, mainly green. |

## AREA 8 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Paradys**......... | **Bloemfontein**... | Jan., 1934 | ·15 | ·35 | ·19 | 2·76 | ·06 | ·53 | 13·3 | 30·3 | 5·49 | Grass, green. |
| | | April, 1934 | ·11 | ·24 | ·11 | 1·00 | ·01 | ·22 | 6·0 | 34·2 | 2·16 | Grass. |
| | | July, 1934 | ·043 | ·22 | ·07 | ·56 | ·01 | ·09 | 2·7 | 38·3 | 1·37 | Grass, brown. |
| | | Oct., 1934 | ·13 | ·33 | ·08 | ·95 | trace | — | 8·0 | — | 2·76 | Grass, mainly green, short. |
| | | Feb., 1935 | ·084 | ·21 | ·06 | 1·26 | trace | ·07 | 3·9 | 36·1 | 2·56 | Grass. |
| | | June, 1935 | ·11 | ·44 | ·14 | ·92 | ·03 | ·13 | 6·5 | 31·9 | 2·91 | Grass, mainly green, and bush; mostly grass. |
| **Tanhuryne**....... | **Bloemfontein**... | Feb., 1934 | ·13 | ·29 | ·13 | 1·76 | trace | ·26 | 9·6 | 34·7 | 3·78 | Grass, green. |
| | | May, 1934 | ·036 | ·24 | ·09 | ·46 | trace | ·09 | 5·9 | 36·3 | 1·62 | Grass, mainly brown. |
| | | Aug., 1934 | ·044 | ·18 | ·07 | ·28 | trace | ·03 | 3·0 | 38·2 | 1·02 | Grass, brown. |
| | | Dec., 1934 | ·067 | ·28 | ·09 | ·84 | ·04 | ·14 | 5·8 | 39·1 | 2·30 | Grass. |
| | | Mar., 1935 | ·062 | ·23 | ·07 | ·61 | trace | ·21 | 4·9 | 33·0 | 1·87 | Grass, mainly green, and bush; mostly grass. |
| | | Sept., 1935 | ·10 | ·32 | ·14 | ·66 | ·21 | ·23 | 7·3 | 32·6 | 3·72 | Grass, short. |
| **Katvoetjesvlei**..... | **Hoopstad**...... | Nov., 1933 | ·073 | ·26 | ·10 | ·96 | ·02 | ·14 | 7·4 | 31·9 | 2·60 | Grass, short. |
| | | May, 1934 | — | ·26 | ·13 | ·75 | ·01 | — | 3·4 | 42·0 | 2·01 | Grass, mainly brown, and bush; mostly grass. |
| | | Aug., 1934 | ·047 | ·16 | ·07 | ·43 | trace | ·06 | 4·6 | 38·4 | 1·40 | Grass, mainly brown, short. |
| | | Nov., 1934 | ·11 | ·24 | ·12 | 1·65 | ·03 | ·36 | 7·7 | 36·4 | 3·35 | Grass, mainly green. |
| | | Feb., 1935 | ·065 | ·25 | ·07 | ·86 | trace | ·15 | 5·1 | 38·2 | 2·06 | Grass, green. |
| | | May, 1935 | ·06 | ·23 | ·09 | ·51 | trace | ·08 | 3·7 | 41·1 | 1·68 | Grass and bush; mostly grass. |
| | | Aug., 1935 | ·088 | ·25 | ·11 | ·70 | ·07 | ·16 | 5·5 | 34·9 | 2·13 | Grass, mainly brown, short. |
| **Wintershoek**..... | **Hoopstad**...... | Dec., 1933 | ·17 | ·45 | ·19 | 2·36 | ·05 | ·39 | 12·5 | 28·6 | 5·17 | Grass, green, and bush; mostly grass. |
| | | Mar., 1934 | ·16 | ·34 | ·20 | 1·82 | ·04 | ·46 | 9·8 | 32·8 | 4·28 | Grass, green. |
| | | June, 1934 | ·07 | ·36 | ·15 | ·53 | ·01 | ·11 | 4·7 | 42·7 | 2·12 | Grass, mainly brown, and bush; mostly grass. |
| | | Sept., 1934 | ·15 | ·44 | ·20 | 1·69 | ·04 | ·43 | 9·6 | 33·8 | 3·71 | Grass, mainly brown, short, and bush: mostly grass. |
| | | Dec., 1934 | ·11 | ·25 | ·13 | 1·60 | ·03 | ·35 | 6·1 | 38·8 | 3·06 | Grass, green. |
| | | Mar., 1935 | ·056 | ·27 | ·08 | ·97 | trace | ·14 | 5·9 | 36·2 | 2·40 | Grass, mainly green. |
| | | June, 1935 | ·12 | ·55 | ·28 | 1·17 | trace | ·21 | 8·4 | 37·2 | 3·73 | Grass, mainly brown, and bush. |
| | | Sept., 1935 | ·093 | ·36 | ·11 | ·85 | ·02 | ·11 | 5·4 | 36·6 | 2·57 | Grass and bush; mostly grass. |
| **Rustvlei**......... | **Hoopstad**...... | Jan., 1934 | ·16 | ·29 | ·15 | 2·16 | ·12 | ·39 | 9·1 | 38·3 | 4·13 | Grass, mainly green. |
| | | April, 1934 | ·11 | ·28 | ·12 | 1·15 | ·02 | ·25 | 5·9 | 40·3 | 2·81 | Grass. |
| | | July, 1934 | ·098 | ·35 | ·10 | ·51 | ·01 | ·09 | 3·4 | 34·4 | 1·93 | Grass, brown, leafy. |
| | | Oct., 1934 | ·10 | ·56 | ·19 | 1·51 | ·03 | ·46 | 7·3 | 33·3 | 3·85 | Grass, mainly green. |
| | | Jan., 1935 | ·075 | ·31 | ·13 | ·79 | ·02 | ·19 | 5·4 | 37·6 | 2·18 | Grass, mainly green. |
| | | April, 1935 | ·11 | ·32 | ·12 | 1·17 | ·14 | ·21 | 6·8 | 31·1 | 2·81 | Grass, mainly green, short. |
| | | July, 1935 | ·092 | ·36 | ·11 | ·63 | ·02 | ·10 | 4·1 | 37·6 | 2·40 | Grass, brown and bush: mostly grass. |
| | | Oct., 1935 | ·089 | ·42 | ·12 | 1·08 | ·05 | ·26 | 6·0 | 32·7 | 3·31 | Grass. |

AREA 8 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Maud Allan**...... | Kroonstad..... | April, 1934 | ·11 | ·29 | ·17 | 1·18 | ·03 | ·32 | 6·0 | 36·2 | 2·66 | Grass, mainly green. |
| | | July, 1934 | ·065 | ·26 | ·09 | ·70 | ·01 | ·05 | 5·2 | 36·9 | 2·11 | Grass, brown. |
| | | Oct., 1934 | ·096 | ·25 | ·13 | 1·29 | trace | ·23 | 6·2 | 34·7 | 2·64 | Grass, mainly green. |
| | | Jan., 1935 | ·076 | ·25 | ·11 | 1·17 | ·02 | ·22 | 5·7 | 35·4 | 2·37 | Grass, mainly green. |
| **Mooidam**......... | Kroonstad..... | Feb., 1934 | ·19 | ·22 | ·17 | 2·40 | ·04 | ·59 | 8·3 | 36·6 | 4·25 | Grass, mainly green. |
| | | May, 1934 | ·05 | ·50 | ·10 | ·64 | trace | ·13 | 3·8 | 33·5 | 2·58 | Grass, leafy. |
| | | Aug., 1934 | ·055 | ·31 | ·10 | ·22 | trace | ·02 | 3·8 | 37·6 | 1·45 | Grass, mainly brown. |
| | | Nov., 1934 | ·11 | ·25 | ·06 | 1·62 | trace | ·21 | 5·7 | 37·1 | 2·47 | Grass, mainly green. |
| | | May, 1935 | ·10 | ·32 | ·13 | ·44 | trace | ·09 | 3·3 | 36·8 | 1·74 | Grass, mainly brown. |
| | | Aug., 1935 | ·044 | ·34 | ·12 | ·16 | ·02 | ·08 | 2·0 | 41·2 | 1·74 | Grass, brown, leafy. |
| **Lerna**............ | Kroonstad..... | Mar., 1934 | ·11 | ·24 | ·14 | 2·63 | ·03 | ·90 | 9·3 | 32·9 | 4·95 | Grass, mainly green. |
| | | June, 1934 | ·068 | ·23 | ·14 | ·42 | ·02 | ·10 | 2·4 | 38·1 | 1·56 | Grass, mainly brown. |
| | | Dec., 1934 | ·12 | ·31 | ·12 | 1·34 | ·24 | ·36 | 6·4 | 33·1 | 3·13 | Grass, mainly green. |
| | | Mar., 1935 | ·10 | ·30 | ·07 | ·88 | trace | ·18 | 6·1 | 37·0 | 2·35 | Grass, mainly green, leafy |
| | | June, 1935 | ·072 | ·31 | ·10 | ·38 | trace | ·07 | 3·4 | 37·3 | 1·52 | Graws, brown, leafy. |
| | | Sept., 1935 | ·06 | ·26 | 07 | ·22 | ·02 | ·19 | 4·2 | 38·2 | 1·47 | Grass, brown, leafy. |
| **Palmietkuil**...... | Winburg....... | Dec., 1933 | ·17 | ·30 | ·11 | 1·88 | ·05 | ·25 | 9·5 | 33·9 | 3·83 | Grass, mainly green. |
| | | Mar., 1934 | ·098 | ·39 | ·10 | 1·29 | ·02 | ·16 | 5·8 | 31·0 | 2·96 | Grass, mainly green. |
| | | June, 1934 | ·07 | ·44 | ·09 | ·34 | ·09 | ·13 | 3·4 | 35·4 | 2·12 | Grass, mainly brown. |
| | | Dec., 1934 | ·10 | ·34 | ·08 | ·98 | trace | ·24 | 5·9 | 34·9 | 2·45 | Grass, green, leafy. |
| | | Mar., 1935 | ·07 | ·35 | ·04 | ·44 | ·02 | ·08 | 4·1 | 33·7 | 1·76 | Grass, mainly brown, leafy. |
| | | June, 1935 | ·052 | ·24 | ·07 | ·20 | trace | ·05 | 2·9 | 35·8 | 1·24 | Grass, brown, leafy. |
| | | Sept., 1935 | ·054 | ·26 | ·06 | ·15 | ·02 | ·02 | 3·1 | 34·3 | 1·40 | Grass, brown, leafy. |
| **Koppiesfontein Wes** | Winburg....... | Jan., 1934 | ·17 | ·30 | ·12 | 1·86 | ·03 | ·43 | 6·3 | 40·1 | 3·40 | Grass, green. |
| | | April, 1934 | ·14 | ·37 | ·12 | 1·00 | ·03 | ·18 | 4·8 | 34·2 | 2·68 | Grass, mainly green. |
| | | July, 1934 | ·075 | ·23 | ·08 | ·26 | ·01 | ·04 | 2·3 | 40·6 | 1·32 | Grass, brown. |
| | | Oct., 1934 | ·07 | ·31 | ·11 | ·33 | ·03 | ·05 | 3·8 | 34·5 | 1·64 | Grass, brown, leafy. |
| | | Jan., 1935 | ·082 | ·25 | ·13 | 1·09 | ·02 | ·23 | 4·3 | 34·6 | 2·33 | Grass, mainly green, leafy. |
| | | April, 1935 | ·11 | ·33 | ·14 | ·53 | ·08 | ·18 | 4·4 | 33·4 | 2·29 | Grass, leafy. |
| | | July, 1935 | ·11 | ·42 | ·09 | ·23 | ·02 | ·07 | 2·8 | 40·8 | 1·72 | Grass, brown, leafy. |
| | | Oct., 1935 | ·073 | ·37 | ·08 | ·33 | ·02 | ·04 | 4·0 | 31·4 | 2·08 | Grass, brown ; leafy. |

## AREA 8 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fraai Uitzicht.... | Winburg....... | Feb., 1934 | ·11 | ·21 | ·11 | 1·24 | ·04 | ·27 | 6·4 | 37·0 | 2·98 | Grass, mainly green. |
| | | May, 1934 | ·12 | ·31 | ·15 | ·67 | ·03 | ·16 | 3·4 | 37·4 | 2·23 | Grass, mainly brown. |
| | | Aug., 1934 | ·078 | ·35 | ·17 | ·19 | trace | ·01 | 3·3 | 32·9 | 1·44 | Grass, brown, leafy. |
| | | Nov., 1934 | ·096 | ·25 | ·09 | ·55 | ·02 | ·10 | 5·3 | 36·7 | 1·67 | Grass, mainly green. |
| | | Feb., 1935 | ·082 | ·21 | ·12 | ·67 | trace | ·08 | 4·4 | 34·7 | 1·60 | Grass, mainly green, leafy. |
| | | May, 1935 | ·11 | ·39 | ·14 | ·35 | trace | ·07 | 3·5 | 34·4 | 1·69 | Grass, mainly brown, leafy. |
| | | Aug., 1935 | ·09 | ·36 | ·16 | ·30 | ·01 | ·07 | 2·4 | 33·1 | 1·83 | Grass, brown, leafy. |
| Welgeluk........ | Brandfort...... | Jan., 1934 | ·16 | ·21 | ·10 | 1·82 | ·04 | ·33 | 6·8 | 41·9 | 3·41 | Grass, mainly green, long. |
| | | April, 1934 | ·083 | ·26 | ·12 | 1·41 | ·02 | ·35 | 4·3 | 39·9 | 2·91 | Grass and bush; mostly grass. |
| | | Nov., 1934 | ·052 | ·38 | ·11 | ·41 | trace | ·06 | 3·4 | 33·8 | 2·43 | Grass, mainly brown and bush; mostly grass. |
| | | Feb., 1935 | ·11 | ·32 | ·08 | ·96 | trace | ·08 | 5·1 | 38·5 | 2·29 | Grass, mainly green. |
| | | June, 1935 | ·12 | ·33 | ·21 | ·69 | trace | ·16 | 5·1 | 31·5 | 2·10 | Grass, leafy. |
| Enkeldoorn....... | Brandfort...... | Mar., 1934 | ·10 | ·27 | ·15 | 1·71 | ·07 | ·36 | 7·4 | 37·1 | 3·54 | Grass, mainly green. |
| | | June, 1934 | ·06 | ·26 | ·07 | ·32 | trace | ·05 | 3·1 | 37·1 | 1·43 | Grass, mainly brown. |
| | | Jan., 1935 | ·08 | ·22 | ·09 | 1·19 | ·02 | ·33 | 4·9 | 40·0 | 2·31 | Grass, mainly green, long. |
| | | April, 1935 | ·093 | ·27 | ·12 | ·80 | ·03 | ·14 | 6·1 | 32·2 | 2·27 | Grass, green, leafy. |
| | | Sept., 1935 | ·12 | ·33 | ·12 | ·59 | ·01 | ·13 | 4·4 | 36·6 | 2·22 | Grass, brown. |
| Spytfontein...... | Brandfort...... | May, 1934 | — | ·32 | ·19 | ·85 | ·02 | — | 5·0 | 34·7 | 2·21 | Grass. |
| | | Dec., 1934 | ·10 | ·28 | ·12 | 1·39 | ·05 | ·33 | 7·5 | 34·0 | 2·89 | Grass, mainly green. |
| | | Mar., 1935 | ·14 | ·40 | ·11 | ·82 | trace | ·12 | 5·7 | 36·1 | 2·42 | Grass, green. |
| | | June, 1935 | ·098 | ·31 | ·11 | ·59 | trace | ·10 | 4·3 | 35·2 | 2·23 | Grass. |

## AREA 9.

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bothashoek No. 24 P.O. Noodshulp | Middelburg..... | Dec., 1933 | ·14 | ·30 | ·12 | 1·45 | ·04 | ·21 | 7·6 | 31·1 | 4·00 | Grass, green, short. |
| | | Mar., 1934 | ·073 | ·18 | ·13 | ·90 | ·03 | ·18 | 6·1 | 32·1 | 2·45 | Grass, mainly green, short. |
| | | June, 1934 | ·047 | ·23 | ·12 | ·52 | trace | ·10 | 3·3 | 31·8 | 2·07 | Grass, mainly brown, short. |
| | | Oct., 1934 | ·073 | ·14 | ·10 | ·65 | ·03 | ·16 | 5·0 | — | 2·01 | Grass, short. |
| | | Jan., 1935 | ·10 | ·53 | ·13 | 1·08 | ·03 | — | — | — | 2·28 | Grass, green, short. |
| | | April, 1935 | ·094 | ·21 | ·10 | ·75 | ·02 | ·20 | 3·2 | 33·1 | 2·24 | Grass, green, short. |
| | | July, 1935 | ·071 | ·18 | ·08 | ·31 | ·07 | ·14 | 2·6 | 34·4 | 1·40 | Grass, mainly brown, short. |
| | | Oct., 1935 | ·057 | ·19 | ·09 | ·34 | ·02 | ·08 | 4·1 | 35·1 | 1·61 | Grass, brown, short. |
| Platfontein No. 237 | Middelburg..... | Jan., 1934 | ·090 | ·23 | ·12 | 1·13 | ·14 | ·40 | 7·5 | 36·8 | 2·75 | Grass, green, short. |
| | | April, 1934 | ·058 | ·19 | ·12 | ·97 | ·02 | ·18 | 4·2 | 30·1 | 1·98 | Grass, mainly green, short. |
| | | July, 1934 | ·042 | ·20 | ·09 | ·41 | ·01 | ·08 | 4·2 | 32·5 | 1·55 | Grass, mainly brown, short. |
| | | Nov., 1934 | ·13 | ·52 | ·18 | 1·80 | ·15 | — | — | — | 4·20 | Grass, green, short. |
| | | Feb., 1935 | ·10 | ·36 | ·14 | ·98 | ·07 | ·21 | 6·0 | 32·5 | 3·08 | Grass, green, short. |
| | | May, 1935 | ·051 | ·39 | ·14 | ·53 | ·07 | ·16 | 3·4 | 30·6 | 2·68 | Grass, short. |
| | | Aug., 1935 | ·049 | ·23 | ·11 | ·41 | trace | ·17 | 2·8 | 33·1 | 2·29 | Grass, brown, short. |
| Mooiwater, P.O. Lammerkop | Middelburg..... | Nov., 1933 | ·11 | ·15 | ·11 | 1·10 | ·02 | ·22 | 7·8 | 32·3 | 2·58 | Grass, green. |
| | | Feb., 1934 | ·095 | ·28 | ·14 | ·99 | ·01 | ·18 | 6·5 | 36·4 | 2·42 | Grass, mainly green. |
| | | May, 1934 | ·061 | ·28 | ·13 | ·42 | ·01 | ·12 | 3·3 | 34·0 | 1·71 | Grass, mainly brown, leafy. |
| | | Aug., 1934 | ·053 | ·24 | ·10 | ·13 | trace | ·01 | 2·6 | 37·1 | 1·21 | Grass, brown, leafy. |
| | | Nov., 1934 | ·083 | ·16 | ·11 | ·95 | ·03 | ·23 | 6·8 | 32·0 | 2·40 | Grass, mainly green, leafy. |
| | | May, 1935 | ·046 | ·21 | ·14 | ·56 | ·02 | ·18 | 3·2 | 35·5 | 1·86 | Grass, short. |
| Bantfontein 234 | Middelburg..... | Dec., 1933 | ·086 | ·19 | ·11 | 1·16 | ·02 | ·21 | 3·8 | 37·6 | 2·13 | Grass. |
| | | Mar., 1934 | ·091 | ·26 | ·16 | 1·29 | ·03 | ·27 | 5·4 | 39·1 | 2·60 | Grass, mainly green, short. |
| | | June, 1934 | ·033 | ·19 | ·08 | ·30 | ·01 | ·06 | 3·5 | 37·0 | 1·15 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·047 | ·27 | ·06 | ·21 | trace | ·03 | 3·3 | 35·3 | 1·24 | Grass, mainly brown, leafy. |
| | | Mar., 1935 | ·074 | ·25 | ·15 | ·86 | trace | ·14 | 4·3 | 37·1 | 2·02 | Grass, mainly green, leafy. |
| | | June, 1935 | ·074 | ·23 | ·09 | ·34 | ·02 | ·08 | 2·8 | 42·2 | 1·66 | Grass, mainly brown, leafy. |
| Hartbeesthoek, P.O. Arnot | Middelburg..... | Jan., 1934 | ·078 | ·22 | ·11 | 1·12 | ·02 | ·22 | 6·2 | 33·4 | 2·49 | — |
| | | April, 1934 | ·10 | ·34 | ·13 | ·92 | ·01 | ·19 | 4·5 | 34·0 | 2·44 | Grass, mainly green, short. |
| | | July, 1934 | ·067 | ·29 | ·05 | ·51 | trace | ·06 | 4·5 | 36·7 | 1·25 | Grass, brown, leafy. |
| | | Jan., 1935 | ·068 | ·21 | ·10 | ·91 | ·02 | ·24 | 3·9 | 36·7 | 2·29 | Grass, mainly green, leafy. |
| | | April, 1935 | ·072 | ·41 | ·10 | ·97 | ·03 | ·21 | 3·9 | 33·8 | 2·60 | Grass, mainly green, leafy. |

### AREA 9 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gemsbokspruit. P.O. Molayta | Middelbrug..... | Nov., 1933 | ·16 | ·60 | ·41 | 4·56 | ·05 | ·57 | 14·0 | 24·3 | 10·60 | Grass, mainly brown and bush. |
| | | Feb., 1934 | ·075 | ·28 | ·13 | 1·39 | trace | ·19 | 5·1 | 37·0 | 3·00 | Grass, mainly green and bush; mostly grass. |
| | | May. 1934 | ·039 | ·32 | ·11 | ·57 | ·02 | ·04 | 3·0 | 37·5 | 1·77 | Grass, mainly brown and bush: mostly grass. |
| | | Aug., 1934 | ·021 | ·17 | ·08 | ·25 | trace | ·03 | 2·7 | 37·2 | ·94 | Grass, brown, short. |
| | | Nov., 1934 | ·12 | ·35 | ·16 | 2·32 | trace | ·23 | 8·3 | 31·6 | 3·99 | Grass, green, leafy. |
| | | Feb., 1935 | ·089 | ·35 | ·13 | 1·34 | trace | ·24 | 6·8 | 37·2 | 3·36 | Grass, green, long. |
| | | May, 1935 | ·063 | ·41 | ·18 | 1·21 | ·12 | ·12 | 6·1 | 31·4 | 2·99 | Grass, mainly brown and bush. |
| | | Aug., 1935 | ·065 | ·48 | ·19 | ·84 | trace | ·21 | 4·1 | 35·1 | 2·83 | Grass, brown, leafy and bush; mostly grass. |
| Vogelstruiskopje, P.O. Ottensville | Middelburg .... | Dec., 1933 | ·20 | 1·78 | ·43 | 2·88 | ·78 | 1·24 | 14·2 | 27·7 | 10·40 | Grass. green and bush. |
| | | Mar., 1934 | ·16 | 1·22 | ·48 | 2·12 | ·42 | ·99 | 10·9 | 28·5 | 7·77 | Grass, green, long and bush mostly grass. |
| | | June, 1934 | ·11 | 1·46 | ·36 | 1·59 | ·29 | ·48 | 7·3 | 40·1 | 7·16 | Grass, long and bush: mostly grass. |
| | | Sept., 1934 | ·037 | ·15 | ·07 | ·04 | ·02 | ·06 | 3·2 | 40·6 | 1·15 | Grass. brown, long. |
| | | Dec., 1934 | ·16 | 1·40 | ·55 | 3·47 | 31 | ·76 | 11·7 | 31·8 | 10·30 | Grass, mainly green, leafy and bush; mostly grass. |
| | | Mar., 1935 | ·18 | 1·36 | ·58 | 2·70 | ·12 | ·73 | 11·3 | 35·3 | 8·40 | Grass, mainly green and bush: mostly grass. |
| | | June, 1935 | ·09 | 1·07 | ·21 | ·67 | ·13 | ·30 | 5·1 | 36·0 | 4·10 | Grass, brown, leafy. |
| | | Sept., 1935 | ·036 | ·60 | ·13 | ·68 | ·03 | ·11 | 3·4 | 39·8 | 2·62 | Grass, brown, long and bush; mostly grass. |
| Zoetvelden....... | Middelburg..... | Jan., 1934 | ·14 | ·36 | ·24 | 2·12 | ·03 | ·16 | 6·9 | 42·3 | 4·95 | Grass, mainly green, long. |
| | | April, 1934 | ·13 | ·29 | ·18 | 2·01 | ·36 | ·80 | 7·1 | 36·7 | 4·54 | Grass, long. |
| | | July, 1934 | ·078 | ·70 | ·09 | ·85 | ·01 | ·10 | 4·8 | 35·8 | 2·32 | Grass, brown, leafy. |
| | | Oct., 1934 | ·032 | ·15 | ·05 | 17 | trace | ·03 | 3·2 | 35·8 | 1·12 | Grass, brown, leafy. |
| | | Jan., 1935 | ·058 | ·24 | ·10 | ·75 | ·02 | ·18 | 4·1 | 36·9 | 1·77 | Grass, mainly green, long. |
| | | April, 1935 | ·043 | ·18 | ·08 | ·46 | ·07 | ·09 | 3·1 | 34·9 | 1·57 | Grass, mainly brown, leafy. |
| | | July, 1935 | ·044 | ·20 | ·11 | ·51 | ·02 | ·14 | 3·2 | 39·7 | 1·39 | Grass, brown, leafy. |
| | | Oct., 1935 | ·056 | ·19 | ·05 | ·56 | ·03 | ·07 | 4·4 | 37·3 | 1·73 | Grass, brown, leafy. |
| Dorpsplaats, P.O. Roossenekal | Middelburg... | Nov., 1933 | ·081 | ·22 | ·10 | ·76 | ·15 | ·35 | 6·2 | 39·7 | 2·55 | Grass. |
| | | Feb., 1934 | ·090 | ·42 | ·17 | 1·37 | ·02 | ·24 | 8·4 | 31·2 | 3·22 | Grass, mainly green, and bush; mostly grass. |
| | | May, 1934 | ·033 | ·37 | ·14 | ·47 | trace | ·14 | 3·0 | 35·7 | 1·90 | Grass, mainly brown. |
| | | Aug., 1934 | ·034 | ·40 | ·11 | ·19 | trace | ·01 | 2·4 | 34·0 | 1·61 | Grass, brown, leafy. |
| | | Nov., 1934 | ·15 | ·36 | ·16 | 1·60 | trace | ·18 | 12·8 | 27·7 | 3·44 | Grass, mainly green, short, and bush; mostly grass. |
| | | Feb., 1935 | ·15 | ·45 | ·10 | 1·31 | trace | ·23 | 8·1 | 29·6 | 3·91 | Grass, green, leafy. |
| | | May, 1935 | ·05 | ·34 | ·12 | ·34 | ·02 | ·08 | 3·2 | 39·5 | 1·95 | Grass, leafy. |
| | | Aug., 1935 | ·039 | ·39 | ·13 | ·38 | trace | ·14 | 2·4 | 36·2 | 2·36 | Grass, brown. |

AREA 9 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| De Lagersdrift No. 106 | Middelburg.... | Dec., 1933 | ·10 | ·32 | ·15 | ·92 | ·02 | ·21 | 6·8 | 37·5 | 2·46 | Grass. |
| | | Mar., 1934 | ·093 | ·77 | ·21 | ·83 | ·02 | ·15 | 6·6 | 33·5 | 4·07 | Grass, mainly green, short, and bush; mostly grass. |
| | | June, 1934 | ·042 | ·39 | ·13 | ·28 | trace | ·07 | 2·4 | 32·4 | 1·78 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·044 | ·47 | ·12 | ·12 | trace | ·02 | 3·7 | 31·3 | 2·08 | Grass, brown, leafy. |
| | | Dec., 1934 | ·11 | ·36 | ·14 | 1·60 | ·03 | ·34 | 8·7 | 29·1 | 4·00 | Grass, green, leafy. |
| | | Mar., 1935 | ·11 | ·39 | ·15 | 1·02 | trace | ·17 | 6·0 | 35·3 | 3·11 | Grass, mainly green, leafy. |
| | | June, 1935 | ·077 | ·43 | ·14 | ·24 | trace | ·07 | 2·7 | 31·5 | 2·22 | Grass, brown, short. |
| | | Sept., 1935 | ·029 | ·37 | ·11 | ·21 | ·04 | ·06 | 2·4 | 33·1 | 2·12 | Grass, brown, short. |
| Diepkloof No. 539 | Middelburg.... | Jan., 1934 | ·18 | ·34 | ·15 | 1·88 | ·03 | ·27 | 8·1 | 35·6 | 4·17 | Grass, mainly green. |
| | | April, 1934 | ·22 | ·28 | ·12 | 1·00 | ·02 | ·04 | 6·0 | 37·4 | 2·72 | Grass. |
| | | July, 1934 | ·066 | ·31 | ·10 | ·32 | trace | ·07 | 2·9 | 38·9 | 1·91 | Grass, brown. |
| | | Oct., 1934 | ·13 | ·28 | ·09 | ·47 | ·02 | ·07 | 2·4 | 41·2 | 1·98 | Grass, brown, long. |
| | | Jan., 1935 | ·17 | ·31 | ·15 | 1·61 | ·05 | ·55 | 9·4 | 30·7 | 3·87 | Grass, green, leafy. |
| | | April, 1935 | ·087 | ·38 | ·17 | 1·88 | trace | ·61 | 4·6 | 35·8 | 4·17 | Grass, mainly green, long. |
| | | July, 1935 | ·092 | ·34 | ·12 | ·81 | ·02 | ·15 | 2·7 | 34·9 | 1·99 | Grass, brown, leafy. |
| | | Oct., 1935 | ·058 | ·40 | ·08 | ·43 | trace | ·05 | 2·5 | 31·0 | 1·91 | Grass, brown, leafy. |
| Olifantslaagte No. 115, P.O. Leeuwklip | Middelburg.... | Dec., 1933 | ·13 | ·27 | ·21 | 1·52 | ·03 | ·25 | 9·7 | 31·4 | 3·30 | Grass, mainly green, short. |
| | | Mar., 1934 | ·079 | ·39 | ·17 | ·83 | trace | ·15 | 6·9 | 32·9 | 2·41 | Grass, green, short. |
| | | Sept., 1934 | ·037 | ·21 | ·07 | ·13 | trace | — | 3·9 | 35·6 | 1·12 | Grass, brown, leafy. |
| Elandspruit No. 507 | Middelburg.... | Nov., 1933 | ·065 | ·21 | ·09 | ·48 | ·02 | ·13 | 4·1 | 37·1 | 1·83 | Grass, short. |
| | | Feb., 1934 | ·065 | ·21 | ·16 | 1·16 | ·03 | ·24 | 6·4 | 33·8 | 2·42 | Grass, mainly green, short. |
| | | May, 1934 | ·030 | ·24 | ·13 | ·51 | trace | ·14 | 3·0 | 36·6 | 1·78 | Grass, mainly brown, short. |
| | | Aug., 1934 | ·047 | ·31 | ·13 | ·38 | ·01 | ·08 | 4·1 | 32·8 | 2·35 | Grass, brown, short. |
| | | Dec., 1934 | ·12 | ·22 | ·11 | 1·57 | ·07 | — | — | — | 3·27 | Grass, green, short. |
| | | Mar., 1935 | ·075 | ·17 | ·10 | ·55 | trace | ·10 | 5·7 | 34·6 | 1·78 | Grass, mainly green, short. |
| | | June, 1935 | ·073 | ·12 | ·06 | ·27 | trace | ·06 | 3·1 | 33·5 | 1·00 | Grass, mainly brown, short. |
| | | Sept., 1935 | ·028 | ·11 | ·05 | ·27 | ·02 | ·09 | 3·3 | 32·4 | 1·01 | Grass, brown, short. |
| Waterhoutboom No. 523, P.O. Graskop | Pilgrimsrest.... | Nov., 1933 | ·11 | ·24 | ·16 | 1·59 | ·08 | ·40 | 7·2 | 34·0 | 3·45 | Grass, green. |
| | | Feb., 1934 | ·10 | ·16 | ·13 | 1·48 | ·13 | ·42 | 6·1 | 39·5 | 2·99 | Grass, mainly green, and bush; mostly grass. |
| | | May, 1934 | ·07 | ·22 | ·17 | ·85 | ·13 | ·40 | 3·6 | 39·6 | 2·25 | Grass. |
| | | Aug., 1934 | ·037 | ·24 | ·12 | ·15 | trace | ·02 | 2·3 | 43·3 | 1·25 | Grass, brown. |
| | | Nov., 1934 | ·079 | ·27 | ·17 | ·95 | ·03 | ·30 | 6·2 | 38·0 | 2·49 | Grass, mainly green, leafy. |
| | | July, 1935 | ·057 | ·30 | ·13 | ·39 | ·03 | ·12 | 3·4 | 38·2 | 2·15 | Grass, mainly brown, short. |
| | | Oct., 1935 | ·050 | ·23 | ·08 | ·29 | ·02 | ·03 | 3·5 | 38·1 | 1·81 | Grass, brown, short. |

### AREA 9 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Injaka No. 251, Bushbuckridge | Pilgrimsrest.... | Dec., 1933 | ·12 | ·25 | ·19 | 1·56 | ·05 | ·44 | 7·1 | 36·2 | 3·30 | Grass, mainly green. |
| | | Mar., 1934 | ·088 | ·30 | ·16 | 1·30 | trace | ·30 | 6·9 | 42·5 | 2·69 | Grass, mainly green, and bush; mostly grass. |
| | | June, 1934 | ·066 | ·27 | ·12 | ·73 | ·01 | ·17 | 3·7 | 36·0 | 1·88 | Grass. |
| | | Sept., 1934 | ·030 | ·24 | ·10 | ·06 | ·02 | ·03 | 3·3 | 36·1 | 1·14 | Grass, brown. |
| | | Dec., 1934 | ·061 | ·19 | ·09 | ·58 | trace | ·07 | 5·5 | 35·3 | 2·13 | Grass, leafy. |
| | | Mar., 1935 | ·12 | ·26 | ·13 | 1·44 | ·03 | ·32 | 6·0 | 34·4 | 3·71 | Grass, short. |
| | | June, 1935 | ·069 | ·32 | ·17 | ·85 | ·06 | ·27 | 4·4 | 38·2 | 2·49 | Grass, mainly brown, leafy. |
| | | Sept., 1935 | ·067 | ·32 | ·18 | 1·30 | ·07 | ·51 | 5·3 | 40·3 | 2·98 | Grass, brown, short. |
| Buffelshoek No. 425, P.O. Cottondale | Pilgrimsrest.... | Jan., 1934 | ·27 | ·27 | ·18 | 2·62 | ·47 | ·53 | 8·7 | 39·3 | 5·50 | Grass, green. |
| | | April, 1934 | ·16 | ·26 | ·12 | 1·31 | ·19 | ·39 | 7·0 | 37·1 | 3·40 | Grass, mainly green. |
| | | Oct., 1934 | ·055 | ·37 | ·15 | ·41 | ·03 | ·11 | 3·7 | 36·0 | 1·86 | Grass, mainly brown. |
| | | Feb., 1935 | ·11 | ·36 | ·22 | 1·35 | ·20 | ·48 | 6·2 | 34·2 | 3·52 | Grass, mainly green. |
| | | May, 1935 | ·11 | ·40 | ·22 | 1·27 | ·11 | ·37 | 5·1 | 35·4 | 3·38 | Grass. |
| | | Aug., 1935 | ·093 | ·34 | ·15 | ·46 | ·02 | ·14 | 2·7 | 40·8 | 1·67 | Grass, mainly brown. |
| Steelpoortdrift No. 684, P.O. Burgersfort | Lydenburg..... | Nov., 1933 | ·26 | 1·00 | ·54 | 3·30 | ·17 | ·16 | 22·5 | 23·2 | 10·10 | Grass and bush; mostly bush. |
| | | Feb., 1934 | ·28 | 1·39 | ·62 | 3·13 | ·21 | ·61 | 16·4 | 24·5 | 11·10 | Grass, green, and bush: mostly bush. |
| | | May, 1934 | ·12 | 1·33 | ·37 | 1·81 | ·05 | ·31 | 11·3 | 26·5 | 6·69 | Bush. |
| | | Aug., 1934 | ·077 | ·56 | ·17 | ·99 | ·03 | ·16 | 6·0 | 31·8 | 3·02 | Grass, brown, long, and buch. |
| | | Feb., 1935 | ·18 | 1·05 | ·27 | 1·78 | ·08 | ·74 | 11·3 | 32·3 | 5·98 | Grass, green, and bush; mostly bush. |
| | | May, 1935 | ·13 | 1·34 | ·52 | 2·01 | ·06 | ·48 | 10·5 | 33·0 | 7·58 | Grass, mainly green, and bush; mostly bush. |
| | | Aug., 1935 | ·084 | ·42 | ·23 | ·87 | ·11 | ·48 | 5·2 | 38·2 | 2·96 | Grass, brown. |
| Blouwblommetjies-kloof No. 399 | Lydenburg..... | Dec., 1933 | ·17 | 1·36 | ·29 | 2·29 | ·35 | ·34 | 12·6 | 27·9 | 7·53 | Grass, mainly green, and bush; mostly grass. |
| | | Mar., 1934 | ·14 | 1·71 | ·52 | 1·51 | ·41 | ·38 | 11·8 | 28·2 | 8·04 | Grass, mainly green, short and, bush; mostly bush. |
| | | June, 1934 | ·093 | 2·59 | ·65 | 1·46 | ·11 | ·40 | 11·7 | 33·7 | 10·10 | Bush. |
| | | Sept., 1934 | ·080 | 3·57 | ·66 | 1·12 | ·45 | 1·70 | 17·1 | 30·2 | 17·10 | Bush. |
| | | Mar., 1935 | ·19 | 1·76 | ·65 | 2·14 | ·58 | ·64 | 15·8 | 27·9 | 10·15 | Bush. |
| | | June, 1935 | ·16 | 2·17 | ·57 | 1·80 | ·18 | ·22 | 13·3 | 29·1 | 9·86 | Bush. |
| | | Sept., 1935 | ·09 | 2·22 | ·58 | 1·10 | ·27 | ·75 | 10·0 | 29·3 | 9·32 | Bush. |
| Schoonoord No. 774 | Lydenburg..... | Jan., 1934 | ·096 | ·70 | ·27 | 1·62 | ·03 | ·51 | 10·7 | 33·4 | 6·86 | Grass, mainly green. |
| | | April, 1934 | ·10 | 1·19 | ·39 | 1·04 | ·04 | ·21 | 12·8 | 30·3 | 4·88 | Grass, mainly green, leafy and bush. |
| | | July, 1934 | ·048 | ·46 | ·25 | ·61 | ·02 | ·11 | 6·4 | 31·1 | 4·02 | Bush. |
| | | Oct., 1934 | ·16 | ·91 | ·26 | 1·39 | ·04 | ·28 | 14·1 | 21·2 | 5·16 | Bush. |
| | | April, 1935 | ·090 | 1·01 | ·38 | ·57 | ·02 | ·19 | 8·0 | 32·4 | 4·34 | Grass, mainly green and bush. |
| | | July, 1935 | ·096 | 1·77 | ·40 | ·86 | ·06 | ·40 | 11·3 | 28·3 | 6·48 | Bush. |
| | | Oct., 1935 | ·17 | ·69 | ·25 | 1·16 | ·03 | ·25 | 13·2 | 24·3 | 4·36 | Grass, leafy and bush; mostly bush. |

AREA 9 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Weltevreden No. 743, P.O. Rustplaats | Lydenburg..... | Nov., 1933 | ·15 | ·27 | ·15 | 1·77 | ·04 | ·56 | 7·7 | 33·5 | 3·96 | Grass, mainly green. |
| | | Feb., 1934 | ·092 | ·26 | ·12 | ·80 | ·03 | ·18 | 5·0 | 39·5 | 2·22 | Grass, mainly green. |
| | | May, 1934 | ·039 | ·18 | ·07 | ·61 | trace | ·09 | 2·9 | 41·0 | 1·50 | Grass, mainly brown, long. |
| | | Aug., 1934 | ·047 | ·22 | ·08 | ·45 | ·01 | ·09 | 2·5 | 40·3 | 1·38 | Grass, brown, long. |
| | | Oct., 1934 | ·22 | ·30 | ·22 | 2·26 | ·05 | ·73 | 9·6 | 31·7 | 4·34 | Grass, green. |
| | | Feb., 1935 | ·064 | ·18 | ·07 | ·81 | ·02 | ·16 | 3·8 | 38·5 | 1·62 | Grass, mainly green, long. |
| | | April, 1935 | ·072 | ·28 | ·16 | ·76 | ·05 | ·17 | 2·9 | 37·7 | 2·12 | Grass, long. |
| | | Sept., 1935 | ·052 | ·44 | ·16 | ·36 | ·05 | ·11 | 3·2 | 34·9 | 2·23 | Grass, brown. |
| Uitspanning No. 502, P.O. Vaalhoek | Pilgrimsrest.... | Dec., 1933 | ·23 | ·34 | ·20 | 2·23 | ·05 | ·39 | 15·1 | 31·2 | 5·17 | Grass, green. |
| | | Mar., 1934 | ·052 | ·14 | ·09 | ·84 | ·01 | ·14 | 3·7 | 42·2 | 1·70 | Grass, long. |
| | | June, 1934 | ·038 | ·18 | ·06 | ·42 | trace | ·10 | 3·7 | 38·5 | 2·70 | Grass, mainly brown. |
| | | Sept., 1934 | ·038 | ·12 | ·06 | ·39 | ·02 | ·04 | 3·2 | 42·5 | 1·03 | Grass, brown, long. |
| | | Jan., 1935 | ·058 | ·14 | ·09 | ·70 | ·02 | ·14 | 4·4 | 40·0 | 1·38 | Grass, mainly green. |
| | | May, 1935 | ·056 | ·29 | ·13 | ·42 | ·02 | ·11 | 2·9 | 40·7 | 1·69 | Grass, mainly brown. |
| Krugerspost...... | Lydenburg..... | April, 1934 | ·050 | ·21 | ·14 | ·75 | ·01 | ·14 | 4·1 | 42·2 | 1·85 | Grass, mainly brown, long. |
| | | July, 1934 | ·036 | ·23 | ·11 | ·36 | trace | ·11 | 2·5 | 41·0 | 1·70 | Grass, brown, long. |
| | | Nov., 1934 | ·065 | ·23 | ·09 | ·59 | ·02 | ·10 | 4·9 | 39·3 | 1·55 | Grass, mainly green. |
| | | Mar., 1935 | ·084 | ·17 | ·11 | 1·11 | trace | ·13 | 4·9 | 39·2 | 2·30 | Grass, mainly green, long. |
| Kranskloof No. 143, P.O. Krugerspost | Lydenburg..... | Nov., 1933 | ·14 | ·22 | ·14 | 1·15 | ·04 | ·28 | 9·6 | 32·6 | 2·87 | Grass, mainly green. |
| | | Feb., 1934 | ·12 | ·22 | ·10 | 1·23 | ·03 | ·15 | 8·5 | 37·5 | 2·55 | Grass. |
| | | June, 1934 | ·081 | ·41 | ·11 | ·57 | ·02 | ·12 | 7·5 | 34·7 | 2·21 | Grass, mainly brown, leafy. |
| | | Nov., 1934 | ·14 | ·25 | ·14 | 1·26 | ·04 | ·27 | 11·1 | 35·2 | 2·82 | Grass, green. |
| | | May, 1935 | ·036 | ·23 | ·10 | ·27 | trace | ·07 | 3·7 | 40·1 | 1·52 | Grass, mainly brown, leafy. |
| | | Aug., 1935 | ·059 | ·26 | ·08 | ·16 | trace | ·06 | 3·2 | 38·8 | 1·30 | Grass, brown, leafy. |
| Kraaibosch No. 145 | Lydenburg..... | Dec., 1933 | ·10 | ·18 | ·13 | 2·05 | ·04 | ·19 | 7·3 | 33·1 | 2·27 | Grass, green. |
| | | Mar., 1934 | ·083 | ·21 | ·14 | ·78 | ·03 | ·18 | 7·0 | 35·5 | 1·88 | Grass, mainly green. |
| | | May, 1934 | ·036 | ·31 | ·18 | ·43 | ·01 | ·08 | 4·3 | 33·2 | 1·55 | Grass, mainly brown, leafy. |
| | | June, 1935 | ·076 | ·27 | ·08 | ·37 | trace | ·07 | 3·9 | 37·2 | 1·86 | Grass, brown, leafy. |
| | | Sept., 1935 | ·036 | ·23 | ·07 | ·09 | ·09 | ·08 | 3·3 | 34·6 | 1·24 | Grass, brown, short. |
| Sterkspruit No.159 | Lydenburg..... | Jan., 1934 | ·18 | ·27 | ·13 | 1·24 | ·06 | ·26 | 6·2 | 36·4 | 3·37 | Grass, green. |
| | | April, 1934 | ·081 | ·22 | ·17 | ·95 | ·03 | ·16 | 6·1 | 36·7 | 2·23 | Grass, mainly green. |
| | | July, 1934 | ·049 | ·45 | ·13 | ·30 | ·02 | ·10 | 2·8 | 38·4 | 1·75 | Grass, brown. |
| | | July, 1935 | ·043 | ·29 | ·10 | ·17 | ·01 | ·08 | 2·9 | 42·5 | 1·38 | Grass, brown. |
| | | Oct., 1935 | ·17 | ·43 | ·19 | 1·64 | ·04 | ·47 | 13·4 | 34·7 | 3·49 | Grass, green, leafy. |
| The Retreat..... | Barberton...... | Dec., 1933 | ·12 | ·34 | ·15 | ·87 | ·03 | ·62 | 5·4 | 35·4 | 2·57 | Grass, mainly green. |
| | | Mar., 1934 | ·10 | ·34 | ·16 | 1·03 | ·01 | ·32 | 5·6 | 33·9 | 2·94 | Grass, short. |
| | | June, 1934 | ·044 | ·34 | ·19 | ·71 | ·01 | ·30 | 2·4 | 35·0 | 2·57 | Grass, mainly brown, short. |
| | | Aug., 1934 | ·047 | ·33 | ·17 | ·34 | trace | ·09 | 3·1 | 37·2 | 1·71 | Grass, mainly brown, short. |
| | | Nov., 1934 | ·072 | ·31 | ·08 | ·48 | ·04 | ·13 | 3·4 | 36·5 | 2·06 | Grass, brown, short. |
| | | Feb., 1935 | ·11 | ·44 | ·17 | 1·13 | ·05 | ·33 | 6·8 | 32·7 | 3·43 | Grass, mainly green, short. |
| | | April, 1935 | ·052 | ·38 | ·16 | ·84 | trace | ·08 | 5·4 | 36·9 | 2·68 | Grass, mainly green, leafy. |

## AREA 9 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goedehoop No. 259 | Barberton...... | Jan., 1934 | ·18 | ·32 | ·23 | 1·17 | ·03 | ·29 | 7·0 | 36·8 | 3·38 | Grass. |
| | | April, 1934 | ·18 | ·26 | ·25 | 1·06 | ·04 | ·20 | 6·3 | 39·1 | 2·98 | Grass, short. |
| | | July, 1934 | ·17 | ·21 | ·14 | 1·01 | ·03 | ·20 | 5·7 | 37·9 | 2·53 | Grass, short. |
| | | Oct., 1934 | ·12 | ·19 | ·12 | ·50 | ·03 | ·08 | 3·0 | 36·8 | 1·68 | Grass, brown, short. |
| | | Jan., 1935 | ·12 | ·31 | ·30 | 1·03 | ·03 | ·35 | 4·9 | 37·6 | 2·80 | Grass, mainly green, leafy. |
| My Own No. 98.. | Barberton...... | Feb., 1934 | ·096 | ·27 | ·29 | ·96 | ·05 | ·34 | 6·6 | 35·2 | 2·74 | Grass, mainly green. |
| | | May, 1934 | ·064 | ·21 | ·21 | ·54 | ·03 | ·23 | 5·3 | 35·4 | 1·82 | Grass, short. |
| Sabieshoek No. 135, P.O. Sabie | Pilgrimsrest.... | Nov., 1933 | ·16 | ·35 | ·27 | 1·86 | ·14 | ·64 | 10·3 | 34·2 | 4·59 | Grass, green. |
| | | Feb., 1934 | ·089 | ·26 | ·19 | 1·08 | ·13 | ·27 | 5·4 | 36·6 | 2·97 | Grass, mainly green, short. |
| | | May, 1934 | ·10 | ·25 | ·29 | 1·19 | ·03 | ·18 | 5·8 | 35·3 | 2·64 | Grass. |
| | | Aug., 1934 | ·065 | ·21 | ·14 | ·51 | ·01 | ·07 | 3·2 | 45·5 | 1·76 | Grass, brown. |
| | | Nov., 1934 | ·14 | ·24 | ·18 | 1·55 | ·06 | ·38 | 10·0 | 35·5 | 3·28 | Grass, green, leafy. |
| | | Aug., 1935 | ·091 | ·27 | ·13 | ·51 | trace | ·08 | 3·0 | 41·8 | 1·82 | Grass, brown. |
| | | Nov., 1935 | ·14 | ·48 | ·15 | 1·39 | trace | ·32 | 7·1 | 34·6 | 3·56 | Grass, green, leafy. |
| Rietfontein No. 84 P.O. Sabie | Pilgrimsrest.... | Dec., 1933 | ·079 | ·37 | ·16 | ·92 | ·03 | ·33 | 6·4 | 36·6 | 3·57 | Grass, mainly brown. |
| | | April, 1934 | ·11 | ·30 | ·14 | 1·25 | ·03 | ·27 | 5·7 | 33·2 | 2·88 | Grass. |
| | | July, 1934 | ·065 | ·44 | ·18 | ·66 | ·02 | ·20 | 5·1 | 36·2 | 2·38 | Grass, mainly brown and bush; mostly grass. |
| | | Oct., 1934 | ·058 | ·31 | ·13 | ·55 | ·05 | ·19 | 4·5 | 35·1 | 2·20 | Grass. |
| | | July, 1935 | ·067 | ·27 | ·12 | ·23 | ·04 | ·08 | 4·1 | 39·6 | 1·53 | Grass, brown, leafy. |
| | | Oct., 1935 | ·087 | ·20 | ·06 | ·70 | ·01 | ·11 | 13·0 | 33·2 | 2·48 | Grass, leafy. |
| Lot No. 30, P.O. Goudstroom | Pilgrimsrest.... | Jan., 1934 | ·15 | ·42 | ·23 | 1·99 | ·04 | ·54 | 6·4 | 39·0 | 4·76 | Grass, mainly green. |
| | | April, 1934 | ·088 | ·23 | ·16 | 1·28 | ·03 | ·38 | 5·7 | 36·6 | 2·82 | Grass. |
| | | June, 1934 | ·077 | ·25 | ·12 | ·93 | ·02 | ·31 | 3·6 | 39·0 | 2·29 | Grass, mainly brown. |
| | | Sept., 1934 | ·043 | ·25 | ·18 | ·39 | trace | ·10 | 3·2 | 41·7 | 1·75 | Grass, mainly brown. |
| | | Dec., 1934 | ·11 | ·22 | ·15 | 1·96 | ·03 | ·45 | 8·5 | 36·5 | 3·53 | Grass, green. |
| | | June, 1935 | ·08 | ·27 | ·14 | ·40 | ·02 | ·09 | 3·9 | 38·8 | 1·63 | Grass, brown, leafy. |
| | | Sept., 1935 | ·046 | ·21 | ·11 | ·38 | ·03 | ·07 | 4·0 | 37·9 | 1·75 | Grass, brown, short. |
| | | Dec., 1935 | ·09 | ·28 | ·15 | 1·15 | ·04 | ·27 | 6·5 | 35·0 | 3·38 | Grass, mainly green. |
| Louisville, P.O. Louws Creek | Barberton...... | Dec., 1933 | ·14 | ·42 | ·30 | 2·27 | ·11 | ·73 | 10·1 | 31·5 | 5·32 | Grass, green, short. |
| | | Mar., 1934 | ·061 | ·35 | ·18 | 1·22 | ·02 | ·33 | 4·2 | 36·5 | 2·83 | Grass, mainly green. |
| | | July, 1934 | ·071 | ·27 | ·19 | ·62 | ·20 | ·50 | 4·7 | 36·9 | 2·42 | Grass, leafy. |
| | | Jan., 1935 | ·20 | ·32 | ·21 | 1·95 | ·22 | ·52 | 5·5 | 34·7 | 4·18 | Grass, mainly green, leafy. |
| Lancastor, P.O. Eureka | Barberton...... | Feb., 1934 | ·13 | ·25 | ·24 | ·97 | ·09 | ·29 | — | 36·8 | 2·47 | Grass, green. |
| | | Aug., 1934 | ·093 | ·65 | ·32 | ·81 | ·07 | ·21 | 6·7 | 35·1 | 3·34 | Grass, mainly brown and bush; mostly grass. |
| | | Nov., 1934 | ·17 | ·32 | ·15 | ·95 | ·02 | ·25 | 6·3 | 36·5 | 2·76 | Grass, mainly green, leafy. |
| | | Feb., 1935 | ·17 | ·37 | ·24 | 2·29 | ·16 | ·42 | 11·7 | 34·0 | 4·56 | Grass, green, leafy. |
| | | May, 1935 | ·12 | ·42 | ·37 | 1·75 | ·20 | ·69 | 9·2 | 36·4 | 4·54 | Grass, green. |

AREA 9 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Albert Home, P.O. Louws Creek | Barberton...... | Sept., 1934 | ·052 | ·31 | ·09 | ·26 | ·01 | ·09 | 3·5 | 35·9 | 1·60 | Grass, mainly brown. |
| | | Dec., 1934 | ·065 | ·21 | ·30 | ·73 | ·52 | ·40 | 6·5 | 39·4 | 2·80 | Grass, mainly green, leafy. |
| | | Mar., 1935 | ·14 | ·37 | ·18 | 1·29 | ·09 | ·32 | 9·0 | 35·3 | 3·82 | Grass, green. |
| Sterkspruit, P.O. Hectorspruit | Barberton...... | Dec., 1933 | ·15 | ·38 | ·38 | 3·18 | ·25 | ·94 | 7·5 | 37·1 | 6·15 | Grass and bush; mostly grass. |
| | | Mar., 1934 | ·15 | ·66 | ·30 | 1·76 | ·06 | ·61 | 9·2 | 35·0 | 4·93 | Grass and bush; mostly grass. |
| | | July, 1934 | ·082 | ·46 | ·28 | ·75 | ·05 | ·22 | 5·5 | 36·4 | 2·69 | Grass, mainly brown and bush: mostly grass. |
| | | Nov., 1934 | ·14 | ·39 | ·17 | 1·73 | ·11 | ·75 | 11·3 | 36·2 | 3·98 | Grass, mainly green. |
| | | Feb., 1935 | ·094 | ·25 | ·22 | 1·44 | ·28 | ·41 | 6·9 | 40·4 | 3·30 | Grass, green. |
| | | May, 1935 | ·074 | ·29 | ·16 | ·53 | ·09 | ·49 | 5·0 | 37·9 | 3·01 | Grass. |
| | | Aug., 1935 | ·069 | ·26 | ·18 | ·43 | ·15 | ·19 | 3·3 | 40·7 | 2·00 | Grass, brown. |
| Buffelspruit, P.O. Hectorspruit | Barberton...... | Jan., 1934 | ·13 | ·34 | ·30 | 2·51 | ·25 | ·75 | 8·5 | 38·2 | 5·53 | Grass and bush; mostly grass. |
| | | April, 1934 | ·11 | ·49 | ·23 | 1·99 | ·63 | ·80 | 6·1 | 35·8 | 5·04 | Grass and bush: mostly grass. |
| | | June, 1934 | ·11 | ·78 | ·53 | 1·51 | ·06 | ·34 | 8·4 | 32·0 | 4·81 | Grass and bush. |
| | | Sept., 1934 | ·031 | ·48 | ·11 | ·13 | ·03 | ·06 | 2·5 | 40·8 | 1·82 | Grass, brown, long. |
| | | Dec., 1934 | ·12 | ·50 | ·21 | 1·64 | ·12 | ·53 | 7·5 | 35·9 | 3·78 | Grass, mainly green and bush; mostly grass. |
| | | Mar., 1935 | ·084 | ·57 | ·29 | ·56 | ·09 | ·13 | 5·2 | 40·6 | 2·53 | Grass and bush; mostly grass. |
| | | June, 1935 | ·057 | ·34 | ·20 | ·26 | ·04 | ·11 | 3·2 | 38·9 | 1·77 | Grass, mainly brown. |
| | | Sept., 1935 | ·048 | ·23 | ·18 | ·30 | ·13 | ·31 | 2·9 | 42·3 | 1·65 | Grass, brown, long. |
| Richtershoek P.O. Hectorspruit | Barberton...... | Feb., 1934 | ·32 | ·31 | ·17 | 2·46 | ·17 | ·46 | 7·2 | 28·7 | 5·07 | Grass, mainly green. |
| | | May, 1934 | ·15 | ·63 | ·33 | 1·10 | ·04 | ·25 | 9·7 | 32·2 | 3·71 | Grass, mainly green and bush. |
| | | Aug., 1934 | ·073 | ·27 | ·21 | ·86 | ·13 | ·38 | 4·4 | 42·8 | 2·50 | Grass, mainly brown, long. |
| | | Oct., 1934 | ·24 | ·75 | ·28 | 1·44 | ·13 | ·36 | 10·3 | 32·3 | 5·02 | Grass and bush. |
| | | Jan., 1935 | ·13 | ·38 | ·20 | 2·63 | ·19 | 1·08 | 9·6 | 37·8 | 5·32 | Grass, green. |
| | | April, 1935 | ·054 | ·31 | ·14 | ·91 | ·15 | ·37 | 4·1 | 40·4 | 2·85 | Grass, mainly green, long |
| | | July, 1935 | ·049 | ·22 | ·10 | ·23 | ·02 | ·09 | 3·0 | 45·5 | 1·26 | Grass, brown, long. |
| | | Oct., 1935 | ·084 | ·29 | ·09 | ·18 | ·04 | ·04 | 2·7 | 39·3 | 1·33 | Grass, brown, loug. |
| Wilsonskop No. 303 Hectorspruit | Barberton...... | Dec., 1933 | ·079 | ·31 | ·18 | 1·05 | ·08 | ·38 | 6·7 | 40·1 | 2·69 | Grass, mainly green, long. |
| | | June, 1934 | ·087 | ·36 | ·23 | 1·40 | ·16 | ·47 | 4·9 | 38·7 | 3·50 | Grass, mainly green, long. |
| | | Sept., 1934 | ·029 | ·15 | ·10 | ·11 | ·06 | ·09 | 2·4 | 39·0 | 1·01 | Grass, brown, long. |
| | | Dec., 1934 | ·059 | ·26 | ·07 | ·82 | ·12 | ·15 | 5·3 | 38·2 | 2·24 | Grass, long. |
| | | July, 1935 | ·082 | ·36 | ·27 | ·80 | ·11 | ·32 | 4·1 | 42·7 | 2·36 | Grass, mainly brown. |
| | | Sept., 1935 | ·047 | ·28 | ·20 | ·51 | ·17 | ·42 | 3·8 | 41·8 | 2·01 | Grass, brown, long. |

## AREA 9 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mauricedale, P.O. Hectorspruit | Barberton...... | Jan., 1934 | — | ·18 | ·15 | 1·19 | ·48 | — | 6·3 | 42·2 | 2·95 | Grass, mainly green, long. |
| | | Aug., 1934 | ·056 | ·29 | ·16 | ·48 | ·14 | ·23 | 4·3 | 37·5 | 1·81 | Grass, mainly brown. |
| | | Nov., 1934 | ·12 | ·72 | ·21 | 1·13 | ·06 | ·27 | 8·6 | 33·3 | 3·67 | Grass, long and bush; mostly grass. |
| | | Oct., 1935 | ·047 | ·17 | ·08 | ·25 | ·05 | ·04 | 3·3 | 39·4 | 1·24 | Grass, brown, long. |
| Thankerton, No. 268 Hectorspruit | Barberton...... | Feb., 1934 | ·10 | ·23 | ·16 | 1·49 | ·49 | ·70 | 6·4 | 32·4 | 3·93 | Grass, mainly green. |
| | | July, 1934 | ·074 | ·25 | ·24 | 1·03 | ·20 | ·06 | 5·5 | 38·0 | 2·85 | Grass, long. |
| | | Oct., 1934 | ·071 | ·40 | ·23 | ·26 | ·11 | ·09 | 3·5 | 35·6 | 2·10 | Grass, brown, long. |
| | | June, 1935 | ·058 | ·30 | ·22 | ·44 | ·13 | ·41 | 3·9 | 35·1 | 2·52 | Grass, long. |
| Figtree.......... | Barberton...... | Dec., 1933 | ·26 | ·51 | ·38 | 3·35 | 1·02 | 1·34 | 11·6 | 33·8 | 9·00 | Grass, green. |
| | | Oct., 1934 | ·082 | ·25 | ·35 | ·57 | ·40 | ·28 | 6·6 | 39·8 | 2·74 | Grass, mainly brown, long. |
| | | Dec., 1934 | ·15 | ·32 | ·14 | 1·17 | ·25 | ·47 | 6·0 | 37·0 | 3·28 | Grass, mainly green, long. |
| | | Jan., 1935 | ·17 | ·31 | ·23 | 1·73 | ·31 | ·62 | 9·3 | 34·7 | 4·00 | Grass, green ,leafy. |
| | | April, 1935 | ·15 | ·30 | ·22 | ·92 | ·34 | ·35 | 5·3 | 37·6 | 3·15 | Grass. |
| Squamans........ | Barberton...... | April, 1934 | ·25 | ·33 | ·29 | ·80 | 1·06 | ·65 | 7·2 | 37·8 | 3·59 | Grass. |
| | | Nov., 1934 | ·056 | ·24 | ·11 | ·21 | ·02 | ·07 | 3·0 | 40·3 | 1·21 | Grass, brown. |
| | | Feb., 1935 | ·14 | ·25 | ·12 | 1·30 | ·07 | ·33 | 4·8 | 36·2 | 2·77 | Grass, mainly green. |
| | | May, 1935 | ·11 | ·27 | ·12 | ·73 | ·08 | ·18 | 4·4 | 36·3 | 2·26 | Grass, mainly brown, leafy. |
| Coopersdal....... | Barberton...... | Feb., 1934 | ·22 | ·38 | ·31 | 1·88 | ·69 | 1·11 | 7·8 | 33·9 | 5·74 | Grass, short. |
| | | July, 1934 | ·062 | ·53 | ·15 | ·11 | ·05 | ·06 | 4·8 | 38·1 | 2·38 | Grass, brown. |

## AREA 10.

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Leeuwdraai, P.O. Mokeetsi | Letaba........ | Jan., 1934 | — | ·50 | ·23 | 2·36 | ·16 | — | 5·9 | 41·4 | 5·91 | Grass. |
| | | April, 1934 | ·074 | ·33 | ·19 | 1·26 | ·04 | ·37 | 4·8 | 34·8 | 3·10 | Grass and bush ; mostly grass. |
| | | July, 1934 | ·077 | ·42 | ·13 | ·62 | ·06 | ·17 | 3·6 | 39·4 | 2·14 | Grass, brown. |
| | | Nov., 1934 | ·044 | ·21 | ·10 | ·32 | trace | ·11 | 2·6 | 40·3 | 1·48 | Grass, brown, long. |
| | | April, 1935 | ·086 | ·29 | ·16 | 1·15 | ·02 | ·34 | 4·1 | 35·3 | 2·51 | Grass, mainly green, long. |
| | | Aug., 1935 | ·090 | ·44 | ·18 | ·38 | ·06 | ·36 | 2·4 | 36·3 | 2·00 | Grass, brown. |
| Minden, P.O. Rubbervale | Letaba........ | Nov., 1933 | ·14 | ·47 | ·18 | 1·25 | ·05 | ·30 | 7·7 | 36·3 | 3·46 | Grass, mainly brown, and bush. |
| | | Feb., 1934 | ·16 | ·24 | ·20 | 1·78 | ·05 | ·44 | 6·4 | 36·6 | 3·63 | Grass, mainly green. |
| | | May, 1934 | ·28 | ·41 | ·21 | 1·24 | ·07 | ·36 | 5·6 | 35·4 | 3·74 | Grass, leafy and bush ; mostly grass. |
| | | Sept., 1934 | ·054 | ·36 | ·21 | ·22 | ·03 | ·07 | 3·2 | 38·5 | 1·64 | Grass, mainly brown. |
| | | Mar., 1935 | ·14 | ·30 | ·31 | 1·19 | ·05 | ·25 | 4·8 | 35·1 | 2·85 | Grass, mainly green, leafy. |
| | | June, 1935 | ·15 | ·38 | ·20 | 1·05 | ·03 | ·25 | 4·6 | 35·5 | 2·85 | Grass, mainly brown, leafy. |
| | | Sept., 1935 | ·22 | ·42 | ·15 | ·70 | ·05 | ·21 | 3·9 | 39·8 | 2·62 | Grass, brown, leafy. |
| Nationaal, P.O. Rubbervale | Letaba........ | Dec., 1933 | ·11 | ·28 | ·13 | 1·70 | ·24 | ·52 | 8·4 | 32·6 | 3·77 | Grass, green. |
| | | Mar., 1934 | ·14 | ·39 | ·21 | 1·73 | ·08 | ·42 | 5·2 | 38·5 | 4·00 | Grass, mainly green. |
| | | June, 1934 | ·27 | ·46 | ·20 | ·77 | ·14 | ·26 | 4·3 | 35·2 | 3·20 | Grass. |
| | | Oct., 1934 | ·15 | ·32 | ·12 | ·27 | ·02 | ·03 | 2·7 | 38·7 | 1·72 | Grass brown. |
| | | Nov., 1934 | ·26 | ·40 | ·26 | 2·45 | ·09 | ·76 | 15·2 | 27·9 | 5·37 | Grass, green, leafy. |
| | | April, 1935 | ·12 | ·35 | ·30 | 1·35 | ·13 | ·52 | 5·8 | 33·7 | 3·37 | Grass, mainly green. |
| | | July, 1935 | ·10 | ·29 | ·20 | ·56 | ·02 | ·18 | 2·2 | 39·9 | 2·08 | Grass, brown. |
| | | Oct., 1935 | ·10 | ·33 | ·23 | ·51 | ·06 | ·17 | 5·1 | 38·0 | 2·54 | Grass, mainly brown. |
| Toul, P.O. Rubbervale | Letaba........ | Jan., 1934 | ·22 | ·25 | ·23 | 1·89 | ·05 | ·37 | 6·5 | 36·0 | 4·04 | Grass, mainly green. |
| | | April, 1934 | ·062 | ·35 | ·22 | ·67 | ·04 | ·18 | 3·9 | 33·9 | 2·06 | Grass, leafy. |
| | | July, 1934 | ·22 | ·55 | ·18 | ·70 | ·04 | ·16 | 4·2 | 36·5 | 2·85 | Grass, mainly brown, and bush ; mostly grass. |
| | | Aug., 1934 | ·22 | ·49 | ·28 | ·85 | ·05 | ·28 | 4·9 | 37·3 | 3·32 | Grass, mainly brown, and bush ; mostly grass. |
| | | Jan., 1935 | ·30 | ·35 | ·26 | 1·80 | ·04 | ·38 | 5·9 | 34·7 | 4·16 | Grass, mainly green. |
| | | Feb., 1935 | ·26 | ·43 | ·25 | 1·84 | ·06 | ·46 | 7·4 | 35·4 | 4·36 | Grass, green, leafy. |
| | | May, 1935 | ·061 | ·39 | ·19 | ·45 | ·07 | ·12 | 4·2 | 35·6 | 1·95 | Grass, leafy. |
| | | Aug., 1935 | ·23 | ·61 | ·24 | ·70 | ·04 | ·17 | 4·9 | 37·2 | 3·13 | Grass, brown. |
| Homo Crown Lands | Letaba........ | Nov., 1933 | ·053 | ·22 | ·09 | ·30 | ·05 | ·12 | 2·8 | 39·2 | 1·46 | Grass, mainly brown. |
| | | Feb., 1934 | ·083 | ·25 | ·15 | 1·33 | ·41 | ·53 | 6·8 | 38·5 | 3·29 | Grass, mainly green. |
| | | June, 1934 | ·049 | ·26 | ·12 | ·61 | ·03 | ·15 | 3·4 | 38·5 | 1·61 | Grass, mainly brown. |
| | | Sept., 1934 | ·091 | ·22 | ·14 | ·36 | ·09 | ·15 | 2·9 | 40·6 | 1·64 | Grass, brown, long. |
| | | Dec., 1934 | ·089 | ·16 | ·13 | ·52 | ·15 | ·23 | 9·3 | 38·8 | 1·75 | Grass, long. |
| | | Mar., 1935 | ·14 | ·18 | ·12 | ·68 | ·09 | ·23 | 3·8 | 40·8 | 1·85 | Grass, mainly brown, long. |
| | | June, 1935 | ·13 | ·23 | ·09 | ·45 | trace | ·12 | 2·0 | 45·1 | 1·60 | Grass, brown, long. |
| | | Sept., 1935 | ·086 | ·20 | ·11 | ·61 | ·02 | ·20 | 1·8 | 42·3 | 1·69 | Grass, brown, long. |

## AREA 10 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MSimkulu Crown Lands | Letaba........ | Dec., 1933 | ·14 | ·31 | ·20 | 2·47 | ·53 | ·66 | 11·1 | 36·3 | 5·64 | Grass, green, and bush: mostly grass. |
| | | April, 1934 | ·14 | ·27 | ·25 | 1·61 | ·20 | ·56 | 8·2 | 37·0 | 3·85 | Grass. |
| | | July, 1934 | ·041 | ·23 | ·13 | ·66 | ·15 | ·32 | 3·7 | 38·4 | 2·10 | Grass, brown, leafy. |
| | | Nov., 1934 | ·088 | ·75 | ·13 | 1·00 | ·35 | ·44 | 5·3 | 37·8 | 2·65 | Grass, leafy. |
| | | Feb., 1935 | ·083 | ·20 | ·14 | ·89 | ·06 | ·28 | 4·6 | 43·3 | 2·15 | Grass, mainly green. |
| | | May, 1935 | ·062 | ·21 | ·06 | ·40 | ·02 | ·08 | 3·0 | 38·6 | 1·33 | Grass, mainly brown, long. |
| | | Aug., 1935 | ·056 | ·21 | ·07 | ·25 | ·01 | ·07 | 2·2 | 40·0 | 1·27 | Grass, brown, long. |
| Hlanekie Crown Lands | Letaba........ | Jan., 1934 | ·12 | ·31 | ·26 | 2·00 | ·60 | ·59 | 6·7 | 34·6 | 4·76 | Grass, mainly green. |
| | | May, 1934 | ·073 | ·35 | ·21 | 1·12 | ·55 | ·42 | 4·4 | 35·2 | 3·43 | Grass, mainly green, leafy. |
| | | Aug., 1934 | ·046 | ·38 | ·17 | ·39 | ·02 | ·11 | 2·4 | 39·3 | 1·83 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·053 | ·28 | ·10 | ·26 | ·02 | ·05 | 2·2 | 41·9 | 1·43 | Grass, brown, leafy. |
| | | Jan., 1935 | ·089 | ·23 | ·09 | ·60 | ·02 | ·22 | 3·2 | 38·3 | 1·72 | Grass, mainly brown. |
| | | April, 1935 | ·075 | ·20 | ·10 | ·61 | trace | ·22 | 3·0 | 38·1 | 1·56 | Grass, brown, leafy. |
| | | July, 1935 | ·092 | ·11 | ·08 | ·24 | ·02 | ·10 | 1·5 | 51·6 | 1·07 | Grass, brown, long. |
| Mooifontein No. 442 | Letaba........ | Nov., 1933 | ·25 | ·40 | ·40 | 3·15 | ·77 | 1·01 | 17·9 | 28·8 | 8·74 | Grass, green, leafy. |
| | | Feb., 1934 | ·12 | ·22 | ·18 | 1·42 | ·14 | ·35 | 6·0 | 40·3 | 3·05 | Grass, mainly green. |
| | | May, 1934 | ·075 | ·96 | ·23 | ·78 | ·05 | ·27 | 7·3 | 33·2 | 3·92 | Grass, mainly green. |
| | | Aug., 1934 | ·11 | 1·32 | ·27 | ·60 | ·04 | ·20 | 6·2 | 34·7 | 4·60 | Grass, brown, leafy, and bush; mostly grass. |
| | | Nov., 1934 | ·10 | ·72 | ·22 | ·38 | ·02 | ·12 | 7·0 | 33·7 | 3·50 | Grass, brown, and bush. |
| | | Feb., 1935 | ·17 | ·34 | ·25 | 2·39 | ·15 | ·69 | 9·1 | 38·7 | 4·80 | Grass, green. |
| | | Aug., 1935 | ·087 | 1·11 | ·20 | ·85 | ·03 | ·20 | 4·9 | 34·3 | 6·45 | Grass, brown, and bush. |
| Grootrivier....... | Letaba........ | Dec., 1933 | ·26 | ·39 | ·35 | 3·90 | ·37 | ·86 | 14·5 | 31·6 | 7·69 | Grass, green, leafy. |
| | | Mar., 1934 | ·25 | ·47 | ·35 | 2·15 | ·07 | ·63 | 6·8 | 36·2 | 5·40 | Grass, mainly green. |
| | | Sept., 1934 | ·069 | ·22 | ·20 | 1·11 | ·05 | ·12 | 4·2 | 39·6 | 2·85 | Grass, brown. |
| | | Dec., 1934 | ·18 | ·34 | ·18 | 1·82 | ·07 | ·57 | 6·6 | 37·4 | 3·63 | Grass, long. |
| | | Mar., 1935 | ·12 | ·90 | ·29 | 1·16 | ·04 | ·13 | 7·9 | 31·6 | 4·23 | Grass, mainly green, and bush. |
| | | June, 1935 | ·13 | ·99 | ·27 | 1·34 | ·28 | ·58 | 8·3 | 33·5 | 5·53 | Grass, mainly green, and bush. |
| | | Sept., 1935 | ·052 | ·67 | ·20 | ·35 | ·02 | ·18 | 2·4 | 38·2 | 2·70 | Grass, brown, leafy. |
| Bronkhorstfontein | Letaba........ | Jan., 1934 | ·14 | ·27 | ·21 | 2·89 | ·06 | ·48 | 6·5 | 39·7 | — | Grass. |
| | | April, 1934 | ·14 | ·38 | ·21 | 1·59 | ·07 | ·35 | 5·3 | 37·8 | 3·45 | Grass. |
| | | July, 1934 | ·12 | 1·44 | ·37 | 1·15 | ·03 | ·43 | 7·6 | 34·3 | 5·56 | Grass, mainly brown, and bush. |
| | | Oct., 1934 | ·12 | ·43 | ·13 | ·90 | ·10 | ·31 | 7·7 | 34·9 | 4·13 | Grass, brown, and bush. |
| | | April, 1935 | ·095 | ·66 | ·16 | 1·17 | ·03 | ·22 | 7·3 | 30·7 | 3·45 | Grass and bush; mostly grass |
| | | July, 1935 | ·11 | ·54 | ·24 | 1·40 | ·08 | ·35 | 6·0 | 35·7 | 4·12 | Grass and bush. |
| | | Oct., 1935 | ·10 | ·74 | ·23 | ·74 | ·02 | ·11 | 7·6 | 33·9 | 3·89 | Grass, brown, and bush; mostly grass. |

## AREA 10 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Breakfast No. 1190 | Letaba......... | Nov., 1933 | ·21 | ·64 | ·24 | 2·47 | ·10 | ·43 | 17·7 | 31·3 | 6·28 | Grass and bush. |
| | | Feb., 1934 | ·12 | ·42 | ·34 | 2·91 | ·41 | ·36 | 10·9 | 33·3 | 7·50 | Grass, mainly green, and bush; mostly grass. |
| | | Aug., 1934 | ·067 | ·66 | ·22 | ·59 | ·12 | ·27 | 5·6 | 36·8 | 2·99 | Grass, mainly brown, and bush. |
| | | Feb., 1935 | ·12 | ·58 | ·19 | 1·69 | ·15 | ·37 | 9·2 | 35·1 | 4·13 | Grass, green, and bush; mostly grass. |
| Carthage No. 2018 | Letaba......... | Dec., 1933 | ·23 | ·74 | ·42 | 3·52 | ·06 | ·56 | 9·4 | 32·6 | 9·03 | Grass and bush. |
| | | Mar., 1934 | ·15 | ·98 | ·26 | 1·23 | ·20 | ·47 | 6·5 | 36·7 | 4·81 | Grass and bush. |
| | | May, 1934 | ·062 | ·44 | ·31 | 2·15 | ·29 | ·26 | 7·6 | 31·5 | 5·13 | Grass, leafy, and bush; mostly grass. |
| | | Sept., 1934 | ·089 | ·33 | ·21 | ·70 | ·10 | ·27 | 8·6 | 37·6 | 2·22 | Grass, mainly brown, and bush; mostly grass. |
| Setali Ranch No. 300 | Letaba......... | Jan., 1934 | — | ·53 | ·26 | 1·88 | ·07 | — | 7·8 | 34·1 | 4·58 | Grass and bush; mostly grass. |
| | | April, 1934 | ·19 | 1·42 | ·60 | 4·45 | ·15 | ·44 | 16·7 | 26·3 | 11·08 | Grass, leafy, and bush. |
| | | April, 1935 | ·093 | ·64 | ·25 | 1·57 | ·24 | ·49 | 5·8 | 37·6 | 4·45 | Grass. |
| Schraalhans No. 2061 | Letaba......... | Nov., 1933 | ·13 | ·35 | ·17 | 1·80 | ·05 | ·55 | 10·5 | 36·7 | 4·42 | Grass, mainly green, and bush; mostly grass. |
| | | Feb., 1934 | ·18 | ·23 | ·12 | 1·78 | ·05 | ·35 | 7·8 | 37·6 | 3·35 | Grass, mainly green. |
| | | May, 1934 | ·18 | ·31 | ·15 | 1·65 | ·06 | ·40 | 5·8 | 36·3 | 3·66 | Grass. |
| Sedan No. 157... | Letaba....... | Nov., 1933 | ·22 | ·79 | ·25 | 2·86 | ·08 | ·47 | 16·0 | 22·8 | 7·02 | Grass, mainly green, and bush. |
| | | Mar., 1934 | ·16 | ·28 | ·16 | 1·63 | ·04 | ·45 | 7·3 | 37·7 | 3·68 | Grass, green. |
| Murlebrook....... | Letaba......... | Dec., 1933 | ·14 | ·35 | ·17 | 1·62 | ·04 | ·35 | 8·8 | 34·0 | 3·71 | Grass, mainly green. |
| | | April, 1934 | ·16 | ·42 | ·19 | 2·08 | ·05 | ·43 | 7·9 | 30·6 | 4·51 | Grass, short, and bush; mostly grass. |
| Mashutti No. 2324 | Letaba......... | Dec., 1933 | ·15 | ·24 | ·15 | 1·68 | ·03 | ·42 | 7·7 | 39·1 | 4·20 | Grass. |
| | | Mar., 1934 | ·078 | ·30 | ·15 | ·93 | ·02 | ·12 | 7·0 | 39·5 | 2·64 | — |
| | | June, 1934 | ·10 | ·30 | ·15 | 1·53 | ·04 | ·34 | 6·5 | 35·4 | 3·61 | Grass, leafy. |
| | | Sept., 1934 | ·044 | ·29 | ·08 | ·28 | ·01 | ·06 | 4·4 | 38·8 | 1·77 | Grass, brown. |
| | | Dec., 1934 | ·08 | ·19 | ·09 | ·87 | trace | ·22 | 5·9 | 41·9 | 1·98 | Grass, long. |
| | | Sept., 1935 | ·076 | ·28 | ·14 | 1·09 | ·02 | ·45 | 5·4 | 37·1 | 2·75 | Grass, brown. |
| Rooihoogte No. 2308 | Letaba......... | Jan., 1934 | ·14 | ·25 | ·16 | 1·65 | ·02 | ·42 | 9·2 | 34·5 | 4·29 | Grass. |
| | | April, 1934 | ·092 | ·26 | ·16 | 1·69 | ·03 | ·36 | 6·8 | 39·1 | 3·63 | Grass. |
| | | July, 1934 | ·12 | ·44 | ·21 | 1·64 | ·02 | ·34 | 4·8 | 38·1 | 3·33 | Grass. |
| | | Oct., 1934 | ·035 | ·22 | ·06 | ·04 | ·02 | ·02 | 1·8 | 41·3 | 0·92 | Grass, brown, long. |
| | | April, 1935 | ·13 | ·38 | ·19 | 1·30 | ·02 | ·38 | 6·7 | 36·5 | 3·05 | Grass, mainly green, leafy. |
| Broedersdrift No. 1932 | Letaba......... | Feb., 1934 | ·14 | ·28 | ·15 | 2·09 | ·03 | ·42 | 8·2 | 38·9 | 3·96 | Grass, mainly green, long. |
| | | May, 1934 | ·10 | ·32 | ·17 | 1·47 | ·04 | ·36 | 5·7 | 39·5 | 2·91 | Grass, mainly green, long. |

## AREA 10 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dusseldorp....... | Letaba......... | Nov., 1933 | ·37 | ·27 | ·24 | 3·71 | ·20 | ·65 | 10·7 | 33·8 | 7·23 | Grass. |
| | | Aug., 1934 | ·12 | ·27 | ·20 | 1·10 | ·11 | ·58 | 4·2 | 36·3 | 3·02 | Grass, mainly brown. |
| | | Nov., 1934 | ·14 | ·37 | ·15 | 1·43 | ·06 | ·41 | 5·8 | 35·3 | 3·32 | Grass, mainly brown. |
| | | Feb., 1935 | ·17 | ·37 | ·14 | 1·79 | ·06 | ·35 | 6·1 | 35·0 | 3·72 | Grass, green, leafy. |
| Pretoria Farm No. 158 | Letaba......... | Dec., 1933 | ·20 | ·25 | ·14 | 1·75 | ·07 | ·51 | 7·9 | 39·2 | 4·53 | Grass, green. |
| | | July, 1934 | ·089 | ·29 | ·12 | ·89 | ·02 | ·33 | 4·5 | 37·7 | 2·22 | Grass, mainly brown. |
| | | Oct., 1934 | ·11 | ·38 | ·26 | ·56 | ·17 | ·28 | 5·4 | 34·4 | 3·60 | Grass, mainly brown, short. |
| | | Jan., 1935 | ·15 | ·27 | ·31 | 2·15 | ·09 | ·79 | 5·6 | 32·7 | 4·57 | Grass, mainly green, short. |
| The Downs No. 508 | Letaba......... | Jan., 1934 | ·17 | ·29 | ·19 | 1·52 | ·03 | ·33 | 8·6 | 40·3 | 3·62 | Grass, mainly green. |
| | | Sept., 1934 | ·045 | ·30 | ·42 | ·23 | ·06 | ·17 | 3·4 | 36·9 | 2·08 | Grass, brown. |
| | | Dec., 1934 | ·12 | ·23 | ·17 | 1·42 | ·04 | ·51 | 11·3 | 37·0 | 3·08 | Grass, green, leafy. |
| | | Mar., 1935 | ·10 | ·29 | ·17 | 1·12 | ·03 | ·35 | 4·7 | 36·8 | 3·02 | Grass, leafy. |
| Strangersrest..... | Letaba......... | Jan., 1934 | ·15 | ·26 | ·17 | 2·00 | ·03 | ·51 | 7·2 | 39·9 | 3·85 | Grass, mainly green. |
| | | April, 1934 | ·14 | ·50 | ·15 | 1·73 | trace | ·45 | 5·9 | 35·7 | 3·78 | Grass, mainly green. |
| | | Dec., 1934 | ·31 | ·34 | ·23 | 2·50 | ·15 | ·50 | 8·9 | 37·0 | 5·66 | Grass, green, leafy. |
| | | Mar., 1935 | ·14 | ·39 | ·24 | 1·85 | ·06 | ·45 | 6·6 | 33·4 | 3·90 | Grass, mainly green. |
| Bontfontein No.48 | Letaba......... | April, 1934 | ·081 | ·37 | ·15 | ·63 | ·05 | ·16 | 5·9 | 33·7 | 2·19 | Grass. |
| | | June, 1934 | ·095 | ·37 | ·14 | ·55 | ·02 | ·14 | 4·0 | 33·9 | 1·83 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·065 | ·30 | ·09 | ·22 | ·03 | ·04 | 3·4 | 36·1 | 1·47 | Grass, brown, leafy. |
| Modjadjes Location | Letaba......... | Nov., 1933 | ·51 | ·44 | ·11 | ·67 | ·01 | ·62 | 17·0 | 28·2 | 9·50 | Grass, green. |
| | | Mar., 1934 | ·17 | ·33 | ·16 | 2·34 | ·16 | ·66 | 6·9 | 36·3 | 4·92 | Grass, mainly green. |
| | | Sept., 1934 | ·11 | 1·20 | ·27 | ·63 | ·07 | ·20 | 7·8 | 33·4 | 4·80 | Grass, brown, and bush. |
| Maínitwa's Location | Letaba......... | Dec., 1933 | ·23 | ·85 | ·32 | 3·18 | ·16 | ·76 | 16·2 | 32·4 | 8·08 | Grass, mainly green, and bush. |
| | | July, 1934 | ·22 | ·55 | ·20 | 1·11 | ·07 | ·20 | 5·5 | 33·7 | 3·50 | Grass, mainly brown, and bush; mostly grass. |
| Mohogonie Dip Area | Letaba......... | May, 1934 | ·21 | ·31 | ·30 | 1·81 | ·35 | ·60 | 8·5 | 35·7 | 5·28 | Grass, mainly green. |
| | | Aug., 1934 | ·12 | ·71 | ·22 | ·82 | ·04 | ·14 | 6·4 | 33·7 | 3·21 | Grass, mainly brown, and bush. |
| Eiland No. 1134 P.O. Rubbervale | Letaba......... | Nov., 1933 | ·19 | ·52 | ·17 | 1·27 | ·14 | ·31 | 9·3 | 35·0 | 4·16 | Grass, mainly brown, and bush. |
| | | Feb., 1934 | ·17 | ·39 | ·19 | 2·78 | ·07 | ·45 | 8·0 | 41·0 | 4·72 | Grass and bush; mostly grass. |

AREA 10 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boekenhoutbult, P.O. Mokeetsi | Letaba........ | Nov., 1933 | ·45 | ·78 | ·29 | 2·92 | ·23 | ·48 | 18·5 | 24·7 | 8·42 | Grass and bush; mostly bush. |
| | | Feb., 1934 | ·11 | ·21 | ·15 | 1·78 | ·19 | ·32 | 5·0 | 38·2 | 3·47 | Grass, mainly green. |
| | | May, 1934 | ·10 | ·49 | ·29 | 1·98 | ·14 | ·32 | 6·4 | 35·7 | 4·92 | Grass, mainly green, and bush; mostly grass. |
| | | Aug., 1934 | ·069 | ·44 | ·16 | ·81 | ·02 | ·09 | 2·9 | 39·7 | 2·37 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·091 | ·32 | ·18 | ·45 | ·04 | ·08 | 4·5 | 39·7 | 2·05 | Grass, brown, leafy. |
| | | Feb., 1935 | ·25 | ·36 | ·22 | 2·27 | ·07 | ·43 | 7·4 | 36·0 | 4·31 | Grass, green, leafy. |
| | | May, 1935 | ·12 | ·44 | ·20 | 1·08 | ·10 | ·24 | 6·2 | 37·6 | 2·95 | Grass and bush; mostly grass. |
| | | July, 1935 | ·15 | ·36 | ·25 | 1·18 | ·19 | ·08 | 4·7 | 42·5 | 3·64 | Grass. |
| | | Oct., 1935 | ·06 | ·22 | ·09 | ·28 | trace | ·04 | 3·1 | 34·0 | 1·39 | Grass, brown, leafy. |
| Zwartkoppies, P.O. Duivelskloof | Letaba........ | Dec., 1933 | ·31 | ·31 | ·21 | 2·39 | ·12 | ·41 | 12·1 | 32·4 | 5·41 | Grass, green, and bush; mostly grass. |
| | | Mar., 1934 | ·22 | ·52 | ·23 | 1·45 | ·09 | ·46 | 6·0 | 33·9 | 4·34 | Grass, mainly green, and bush; mostly grass. |
| | | Sept., 1934 | ·10 | ·31 | ·20 | ·60 | ·06 | ·15 | 3·0 | 39·2 | 2·30 | Grass, brown. |
| | | Dec., 1934 | ·23 | ·35 | ·32 | 3·42 | ·11 | ·94 | 13·6 | 33·3 | 6·68 | Grass, green, leafy. |
| | | Mar., 1935 | ·17 | ·33 | ·25 | 2·37 | ·09 | ·63 | 7·0 | 35·6 | 4·71 | Grass, mainly green. |
| | | June, 1935 | ·13 | ·58 | ·20 | ·70 | ·03 | ·19 | 4·6 | 39·0 | 2·88 | Grass, brown, and bush: mostly grass. |
| | | Sept., 1935 | ·048 | ·29 | ·14 | ·58 | ·14 | ·24 | 3·9 | 36·3 | 2·30 | Grass, brown. |
| Macheka Location (Klein Letaba) | Zoutpansberg . | Nov., 1933 | ·30 | 1·00 | ·27 | 2·38 | ·23 | ·65 | 17·0 | 25·5 | 6·98 | Grass and bush. |
| | | Feb., 1934 | ·20 | ·34 | ·16 | 1·77 | ·22 | ·48 | 6·3 | 40·3 | 3·74 | Grass, mainly green. |
| | | May, 1934 | ·13 | ·40 | ·19 | 1·25 | ·05 | ·13 | 4·9 | 37·2 | 3·51 | Grass, short. |
| | | Aug., 1934 | ·065 | ·34 | ·21 | ·54 | ·10 | ·26 | 2·8 | 39·4 | 2·18 | Grass, mainly brown, short. |
| | | Nov., 1934 | ·058 | ·43 | ·14 | ·28 | trace | ·06 | 3·6 | 39·8 | 2·31 | Grass, brown. |
| | | Feb., 1935 | ·15 | ·32 | ·14 | 1·20 | ·07 | ·37 | 4·7 | 38·4 | 2·96 | Grass, mainly green. |
| | | May, 1935 | ·098 | ·46 | ·22 | ·68 | ·03 | ·17 | 3·2 | 35·2 | 2·40 | Grass. mainly brown. |
| | | Aug., 1935 | ·093 | ·25 | ·15 | ·80 | ·06 | ·38 | 1·8 | 43·0 | 2·04 | Grass, brown, long. |
| Maheppe Location (Klein Letaba) | Zoutpansberg.. | Jan., 1934 | ·19 | ·30 | ·24 | 2·97 | ·09 | ·71 | 7·5 | 37·0 | 6·60 | Grass, mainly green. |
| | | Mar., 1934 | ·26 | ·42 | ·31 | 2·51 | ·15 | ·59 | 10·7 | 34·4 | 5·92 | Grass, short. |
| | | June, 1934 | ·053 | ·32 | ·29 | ·79 | ·01 | ·19 | 4·3 | 40·2 | 2·85 | Grass. |
| | | Sept., 1934 | ·043 | ·42 | ·20 | ·32 | ·03 | ·07 | 3·9 | 40·2 | 2·06 | Grass, brown. |
| | | Dec., 1934 | ·082 | ·22 | ·22 | ·97 | ·17 | ·38 | 5·8 | 41·4 | 2·65 | Grass, mainly brown, long |
| | | Mar., 1935 | ·14 | ·78 | ·19 | 1·25 | ·39 | ·80 | 8·2 | 31·1 | 4·96 | Grass, mainly green. leafy. |
| | | June, 1935 | ·077 | ·32 | ·25 | 1·00 | ·04 | ·48 | 5·4 | 36·7 | 3·40 | Grass, leafy. |
| | | Sept., 1935 | ·11 | ·39 | ·21 | ·45 | ·27 | ·62 | 3·3 | 44·5 | 2·83 | Grass, brown, long. |

## AREA 10 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nkurie Location (Klein Letaba) | Zoutpansberg.. | Jan., 1934 | ·19 | ·60 | ·24 | 1·81 | ·25 | ·50 | 9·7 | 36·7 | 5·30 | Grass, mainly green, and bush; mostly grass. |
| | | April, 1934 | ·22 | ·46 | ·26 | 2·16 | ·12 | ·47 | 6·4 | 35·7 | 5·46 | Grass, short. |
| | | July, 1934 | ·22 | ·61 | ·23 | 1·34 | ·23 | ·51 | 5·4 | 38·9 | 4·09 | Grass, mainly brown, and bush; mostly grass. |
| | | Oct., 1934 | ·067 | ·39 | ·19 | ·34 | ·03 | ·06 | 3·9 | 36·8 | 3·65 | Grass, brown. |
| | | Jan., 1935 | ·13 | ·32 | ·49 | 1·85 | ·23 | ·74 | 9·5 | 31·1 | 4·62 | Grass, green, short. |
| | | April, 1935 | ·079 | ·42 | ·26 | 1·49 | ·15 | ·48 | 5·7 | 34·0 | 4·07 | Grass. |
| | | July, 1935 | ·10 | 1·00 | ·31 | 1·17 | ·06 | ·29 | 6·7 | 40·8 | 6·06 | Grass, brown, and bush. |
| | | Oct., 1935 | ·086 | ·66 | ·22 | ·53 | ·11 | ·14 | 4·4 | 41·3 | 3·46 | Bush. |
| Kranspoort No. 1000 | Zoutpansberg.. | Nov., 1933 | ·19 | ·77 | ·22 | 3·73 | ·08 | ·43 | 10·1 | 32·1 | 5·94 | Grass and bush. |
| | | Feb., 1934 | ·17 | ·34 | ·31 | 2·08 | ·16 | ·50 | 7·0 | 33·7 | 6·66 | Grass. |
| | | May, 1934 | ·12 | ·35 | ·26 | 1·34 | ·24 | ·59 | 7·1 | 33·0 | 3·56 | Grass, short. |
| Claudinshoop No. 22 | Zoutpansberg.. | Dec., 1933 | ·14 | ·40 | ·17 | 1·86 | ·10 | ·49 | 7·0 | 33·1 | 4·67 | Grass. |
| | | Mar., 1934 | ·071 | ·34 | ·15 | ·99 | ·03 | ·22 | 5·3 | 35·6 | 2·56 | Grass, mainly brown, short. |
| Altenburg........ | Zoutpansberg.. | Jan., 1934 | ·13 | ·23 | ·15 | 1·65 | ·02 | ·38 | 9·3 | 36·8 | 3·43 | Grass and bush. |
| | | April, 1934 | ·086 | ·56 | ·17 | 1·50 | ·14 | ·34 | 8·7 | 27·8 | 3·58 | Grass, short and bush; mostly grass. |
| Riversdale No. 933 | Zoutpansberg.. | Nov., 1933 | ·22 | ·97 | ·34 | 2·74 | ·11 | ·38 | 16·1 | 27·0 | 7·56 | Grass, mainly green, and bush. |
| | | Feb., 1934 | ·087 | ·61 | ·15 | 1·64 | ·02 | ·45 | 6·6 | 30·3 | 4·25 | Grass and bush; mostly grass. |
| | | May, 1934 | ·065 | ·25 | ·08 | ·70 | ·02 | ·16 | 4·6 | 37·1 | 1·94 | Grass, brown, short. |
| | | Aug., 1934 | ·059 | ·20 | ·08 | ·81 | ·01 | ·14 | 4·3 | 37·1 | 1·83 | Grass, brown. |
| | | Nov., 1934 | ·061 | ·16 | ·05 | ·31 | ·03 | ·08 | 3·2 | 37·5 | 1·30 | Grass, brown. |
| Comfornis No. 507 | Zoutpansberg.. | Dec., 1933 | ·19 | ·65 | ·30 | 1·92 | ·08 | ·54 | 7·9 | 36·0 | 5·80 | Grass, mainly green, and bush; mostly grass. |
| | | Mar., 1934 | ·11 | ·72 | ·33 | 2·18 | ·03 | ·46 | 8·2 | 32·7 | 5·88 | Grass. |
| | | June, 1934 | ·048 | ·15 | ·11 | ·81 | ·02 | ·21 | 4·3 | 40·7 | 1·85 | Grass, brown, long. |
| | | Sept., 1934 | ·050 | ·14 | ·07 | ·67 | ·02 | ·12 | 4·4 | 39·1 | 1·35 | Grass, brown, long. |
| Corea No. 663.... | Zoutpansberg.. | Jan., 1934 | ·22 | ·28 | ·15 | 1·24 | ·03 | ·29 | 10·5 | 32·2 | 3·07 | Grass, mainly green, and bush; mostly grass. |
| | | April, 1934 | ·11 | ·43 | ·18 | 1·64 | ·14 | ·80 | 4·3 | 35·3 | 3·62 | Grass, mainly brown, and bush. |
| | | July, 1934 | ·095 | ·22 | ·10 | ·65 | ·02 | ·08 | 2·7 | 38·8 | 1·79 | Grass, brown, and bush; mostly grass. |
| | | Oct., 1934 | ·052 | ·38 | ·09 | ·31 | ·02 | ·05 | 2·8 | 35·4 | 1·80 | Grass, brown. |
| | | Jan., 1935 | ·042 | ·21 | ·06 | ·29 | trace | ·08 | 2·9 | 41·0 | 1·40 | Grass, brown. |

AREA 10 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tshiombo (portion Sibasa Location) | Zoutpansberg.. | Nov., 1933 | ·14 | ·51 | ·28 | 1·20 | ·31 | ·17 | 10·8 | 32·2 | 4·00 | Grass, mainly green, and bush. |
| | | Feb., 1934 | ·15 | ·47 | ·30 | 2·13 | ·10 | ·51 | 18·8 | 35·7 | 5·26 | Grass and bush. |
| | | May, 1934 | ·11 | ·55 | ·31 | 1·56 | ·15 | ·37 | 11·0 | 31·9 | 4·64 | Grass and bush. |
| | | Aug., 1934 | ·18 | ·76 | ·29 | ·85 | ·11 | ·29 | 7·4 | 39·0 | 3·69 | Grass, mainly brown, and bush. |
| | | Nov., 1934 | ·12 | ·49 | ·29 | 1·74 | ·15 | ·55 | 9·6 | 35·7 | 4·58 | Grass, long, and bush; mostly grass. |
| | | Feb., 1935 | ·20 | ·57 | ·38 | 2·44 | ·26 | ·65 | 13·3 | 33·9 | 6·24 | Grass, mainly green, and bush. |
| | | May, 1935 | ·18 | ·54 | ·32 | 1·91 | ·08 | ·34 | 17·0 | 29·4 | 4·94 | Grass and bush; mostly bush. |
| Kalaba (Portion Sibasa Location) | Zoutpansberg.. | Dec., 1933 | ·27 | ·68 | ·28 | 2·41 | ·28 | ·52 | 13·9 | 28·2 | 6·80 | Grass, mainly green, and bush; mostly grass. |
| | | Mar., 1934 | ·14 | ·56 | ·28 | 1·79 | ·11 | ·38 | 9·7 | 35·3 | 5·04 | Grass and bush. |
| | | Sept., 1934 | ·095 | ·54 | ·29 | ·67 | ·16 | ·27 | 7·2 | 34·4 | 2·75 | Grass and bush. |
| | | Dec., 1934 | ·23 | ·43 | ·23 | 4·03 | ·11 | 1·08 | 15·7 | — | 7·54 | Grass, mainly green, leafy, and bush. |
| | | Mar., 1935 | ·14 | ·70 | ·37 | 2·15 | ·11 | ·57 | 8·6 | 38·0 | 5·64 | Grass and bush; mostly grass. |
| | | June, 1935 | ·16 | ·74 | ·39 | 1·89 | ·04 | 1·17 | 11·4 | 31·1 | 5·48 | Grass, green, leafy, and bush; mostly grass. |
| | | Sept., 1935 | ·074 | ·64 | ·25 | ·53 | ·08 | ·22 | 6·3 | 34·0 | 3·10 | Grass, brown, and bush. |
| She Kondo Malema (Sibasa Location) | Zoutpansberg.. | Jan., 1934 | ·25 | ·23 | ·21 | 1·67 | ·50 | ·71 | 6·1 | 40·6 | 4·77 | Grass, long. |
| | | April, 1934 | ·13 | ·68 | ·30 | 1·30 | ·16 | ·37 | 9·2 | 36·5 | 4·13 | Grass and bush. |
| | | July, 1934 | ·10 | 1·06 | ·30 | 1·03 | ·10 | ·25 | 8·1 | 32·5 | 4·69 | Grass, mainly brown, and bush. |
| | | Oct., 1934 | ·10 | ·56 | ·17 | ·39 | ·17 | ·23 | 5·5 | 37·6 | — | Grass, mainly brown, and bush. mostly grass. |
| | | April, 1935 | ·17 | ·43 | ·23 | 1·57 | ·15 | ·10 | 7·0 | 31·3 | 4·50 | Grass, mainly green. |
| | | Oct., 1935 | ·14 | ·51 | ·27 | 1·69 | ·06 | ·54 | 10·4 | 38·1 | 4·62 | Grass, green, and bush: mostly grass. |
| Driefontein No. 110 | Zoutpansberg.. | Nov., 1933 | ·21 | ·34 | ·18 | 2·38 | ·17 | ·61 | 11·3 | 35·2 | 5·12 | Grass, mainly green. |
| | | May, 1934 | ·16 | ·36 | ·20 | 1·53 | ·04 | ·35 | 5·1 | 40·4 | 3·39 | Grass. |
| | | Aug., 1934 | ·084 | ·28 | ·17 | ·63 | trace | ·13 | 3·1 | 39·9 | 1·96 | Grass, brown, long. |
| | | Nov., 1934 | ·16 | ·27 | ·13 | 1·12 | trace | ·57 | 5·3 | 40·2 | 2·73 | Grass, long. |
| | | Feb., 1935 | ·17 | ·28 | ·16 | 1·85 | ·04 | ·58 | 6·0 | 38·0 | 3·63 | Grass, green, long. |
| Gevonden No. 216 | Zoutpansberg.. | Dec., 1933 | ·25 | ·25 | ·17 | 2·27 | ·07 | ·41 | 8·7 | 38·5 | 4·38 | Grass, green. |
| | | Mar., 1934 | ·21 | ·24 | ·18 | 1·40 | ·05 | ·35 | 4·1 | 38·1 | 3·10 | Grass, mainly green. |
| | | June. 1934 | ·12 | ·32 | ·13 | 1·34 | trace | ·17 | 4·2 | 36·8 | 2·13 | Grass, mainly brown. |
| | | Sept., 1934 | ·093 | ·16 | ·11 | ·33 | ·02 | ·11 | 4·7 | 40·6 | 1·49 | Grass, brown‘ long. |
| | | Dec., 1934 | ·10 | ·23 | ·12 | ·89 | ·03 | ·22 | 5·6 | 38·9 | 2·20 | Grass, mainly green, long. |
| Doornspruit No. 199 | Zoutpansberg.. | Jan., 1934 | ·27 | ·22 | ·20 | 1·99 | ·08 | ·43 | 6·2 | 37·7 | 4·37 | Grass, mainly green. |
| | | April, 1934 | ·15 | ·25 | ·14 | 1·70 | ·06 | ·14 | 5·4 | 38·4 | 3·72 | Grass. |
| | | July, 1934 | ·092 | ·36 | ·13 | ·40 | ·04 | ·12 | 2·8 | 37·1 | 1·70 | Grass, brown. |
| | | Oct., 1934 | ·10 | ·28 | ·12 | ·37 | ·03 | ·08 | 2·9 | 39·0 | 1·75 | Grass, mainly brown, long. |
| | | Jan., 1935 | ·12 | ·25 | ·14 | 1·08 | ·08 | ·40 | 5·6 | 37·3 | 2·45 | Grass, mainly green, long. |

## AREA 10 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pepedi (Sibasa)... | Zoutpansberg.. | Nov., 1933 | ·22 | ·72 | ·30 | 1·62 | ·08 | ·20 | 15·9 | 22·7 | 5·53 | Bush. |
| | | Feb., 1934 | ·14 | ·49 | ·30 | 1·76 | ·16 | ·51 | 10·2 | 34·1 | 4·56 | Grass and bush; mostly grass. |
| | | Aug., 1934 | ·048 | ·61 | ·32 | ·39 | ·01 | ·09 | 3·5 | 43·7 | 2·43 | Grass, brown, long, and bush; mostly grass. |
| | | Jan., 1935 | ·18 | ·31 | ·20 | 2·70 | ·09 | ·79 | 8·8 | 34·3 | 4·86 | Grass, green, long. |
| | | April, 1935 | ·14 | ·44 | ·29 | 1·60 | trace | ·32 | 8·3 | 39·6 | 3·73 | Grass and bush; mostly grass. |
| | | July, 1935 | ·076 | ·62 | ·22 | ·82 | ·03 | ·25 | 5·1 | 37·3 | 3·08 | Grass, brown, long, and bush. |
| | | Oct., 1935 | ·076 | ·50 | ·17 | ·73 | ·03 | ·11 | 6·0 | 38·8 | 2·73 | Grass, brown, long, and bush. |
| Natal House (Sibasa) | Zoutpansberg.. | Dec., 1933 | ·23 | ·53 | ·40 | 1·87 | ·18 | ·41 | 9·8 | 33·8 | 5·50 | Grass, mainly green. |
| | | Oct., 1934 | ·091 | ·34 | ·11 | ·38 | ·01 | ·09 | 3·2 | 42·2 | 1·86 | Grass, brown, long. |
| | | Feb., 1935 | ·13 | ·67 | ·34 | 2·29 | ·22 | ·61 | 9·9 | 30·6 | 6·15 | Grass and bush. |
| | | May, 1935 | ·14 | ·43 | ·15 | ·87 | ·07 | ·19 | 5·2 | 36·3 | 2·95 | Grass, long, and bush. |
| | | Aug., 1935 | ·09 | ·83 | ·24 | ·81 | ·05 | ·21 | 6·7 | 34·3 | 3·41 | Grass, mainly brown, and bush; mostly bush. |
| Sterkstroom (Sibasa) | Zoutpansberg.. | Jan., 1934 | ·16 | ·57 | ·31 | 2·41 | ·07 | ·40 | 9·6 | 37·9 | 5·49 | Grass, mainly green. |
| | | April, 1934 | ·18 | ·41 | ·27 | 2·10 | ·09 | ·60 | 7·8 | 36·1 | 4·90 | Grass, mainly green. |
| | | July, 1934 | ·11 | 1·34 | ·25 | 1·06 | ·04 | ·26 | 10·5 | 29·1 | 4·85 | Grass and bush; mostly bush. |
| | | Mar., 1935 | ·077 | ·31 | ·12 | ·53 | ·02 | ·04 | 5·5 | 43·6 | 4·18 | Grass, brown, short, and bush. |
| | | June, 1935 | ·088 | ·79 | ·21 | ·67 | ·02 | ·19 | 6·5 | 38·2 | 3·32 | Grass, brown, long, and bush. |
| Mampakuil No. 225 | Zoutpansberg.. | Nov., 1933 | ·31 | ·40 | ·28 | 2·71 | ·60 | ·77 | 12·9 | 31·5 | 6·90 | Grass, mainly green, short. |
| | | Feb., 1934 | ·084 | ·26 | ·19 | 1·33 | ·36 | ·34 | 5·2 | 36·6 | 3·19 | Grass. |
| | | May, 1934 | ·095 | ·31 | ·15 | ·65 | ·17 | ·28 | 5·1 | 39·0 | 2·17 | Grass. |
| | | Aug., 1934 | ·082 | ·20 | ·07 | ·25 | ·08 | ·05 | 3·8 | 37·9 | 1·20 | Grass, brown. |
| | | Nov., 1934 | ·079 | ·17 | ·07 | ·42 | ·04 | ·08 | 5·0 | 36·0 | 1·39 | Grass, brown. |
| | | Feb., 1935 | ·18 | ·40 | ·20 | 2·27 | ·37 | ·75 | 12·7 | 30·7 | 5·27 | Grass, green, short. |
| | | May, 1935 | ·15 | ·40 | ·14 | 1·11 | ·24 | ·46 | 6·4 | 30·7 | 3·41 | Grass, short. |
| | | Aug., 1935 | ·08 | ·27 | ·11 | ·55 | ·06 | ·18 | 6·1 | 31·2 | 2·46 | Grass, brown, short. |
| Rustgenoeg No. 42 | Zoutpansberg.. | Jan., 1934 | ·13 | ·83 | ·39 | 2·12 | ·29 | ·77 | 11·0 | 30·8 | 6·46 | Grass, mainly green. |
| | | Mar., 1934 | ·11 | ·56 | ·28 | ·94 | trace | ·15 | 8·2 | 32·0 | 3·17 | Grass and bush. |
| | | Jun., 1934 | ·031 | ·16 | ·06 | ·21 | ·02 | ·03 | 3·3 | 39·1 | 0·98 | Grass, brown, long. |
| | | Sept., 1934 | ·045 | ·23 | ·07 | ·26 | ·04 | ·05 | 4·3 | 38·3 | 1·29 | Grass, brown, long. |
| | | Dec., 1934 | ·25 | 1·17 | ·44 | 2·38 | ·09 | ·29 | 20·6 | 25·0 | 8·04 | Bush. |
| | | Mar., 1935 | ·17 | ·58 | ·54 | 1·65 | ·13 | ·35 | 13·0 | 28·9 | 6·14 | Grass, mainly green, leafy |
| Eastlynne........ | Zoutpansberg.. | Feb., 1934 | ·20 | ·21 | ·16 | 1·91 | ·19 | ·56 | 6·8 | 34·7 | 4·31 | Grass, mainly green. |
| | | April, 1934 | ·10 | ·22 | ·14 | ·88 | ·15 | ·38 | 4·2 | 40·7 | 2·18 | Grass. |
| | | July, 1934 | ·16 | ·31 | ·10 | ·70 | ·09 | ·28 | 5·6 | 33·2 | 2·48 | Grass, mainly brown, short. |
| | | Oct., 1934 | ·062 | ·33 | ·18 | ·19 | ·05 | ·04 | 3·2 | 37·5 | 1·68 | Grass, mainly brown. |
| | | Jan., 1935 | ·11 | ·26 | ·16 | 1·01 | ·09 | ·41 | 6·0 | 37·7 | 2·47 | Grass, mainly green. |
| | | April, 1935 | ·078 | ·21 | ·18 | ·72 | ·09 | ·18 | 4·0 | 35·7 | 2·13 | Grass, long. |
| | | July, 1935 | ·058 | ·27 | ·16 | ·48 | ·07 | ·16 | 3·3 | 38·5 | 2·06 | Grass, brown. |
| | | Oct., 1935 | ·056 | ·25 | ·10 | ·30 | ·05 | ·04 | 3·0 | 40·9 | 1·60 | Grass, brown, long. |

AREA 10 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reubander No. 59** | Zoutpansberg.. | Nov., 1933 | ·34 | 1·41 | ·31 | 3·30 | ·04 | ·47 | 13·9 | 23·1 | 8·30 | Bush. |
| | | Feb., 1934 | ·18 | ·62 | ·30 | 3·61 | ·04 | ·51 | 12·7 | 31·8 | 8·08 | Grass, green, and bush; mostly grass. |
| | | May, 1934 | ·12 | ·40 | ·32 | 1·85 | ·07 | ·57 | 5·5 | 37·1 | 4·38 | Grass. |
| | | Aug., 1934 | ·11 | ·62 | ·28 | ·79 | ·05 | ·32 | 4·3 | 34·5 | 3·14 | Grass, brown, and bush; mostly grass. |
| | | Nov., 1934 | ·26 | ·88 | ·34 | 3·31 | trace | 1·11 | 18·0 | 28·5 | 7·21 | Grass, green, and bush; mostly grass. |
| | | Feb., 1935 | ·11 | ·28 | ·24 | 1·72 | ·05 | ·62 | 6·9 | 35·8 | 3·65 | Grass, green. |
| | | May, 1935 | ·17 | ·41 | ·26 | 2·53 | ·39 | ·09 | 8·7 | 31·8 | 5·47 | Grass. |
| | | Aug., 1935 | ·072 | ·55 | ·30 | ·81 | ·10 | ·35 | 4·4 | 39·0 | 2·94 | Grass, brown. |
| **Palmoryville No. 665** | Zoutpansberg.. | Dec., 1933 | ·32 | ·67 | ·31 | 3·35 | ·11 | ·70 | 12·0 | 33·7 | 7·86 | Grass, green, and bush; mostly grass. |
| | | Mar., 1934 | ·13 | ·46 | ·33 | 2·22 | ·04 | ·46 | 9·6 | 36·3 | 4·80 | Grass, mainly green, and bush; mostly grass. |
| | | June, 1934 | ·073 | ·52 | ·27 | ·82 | ·02 | ·13 | 5·0 | 39·2 | 2·90 | Grass, mainly brown. |
| | | Sept., 1934 | ·05 | ·48 | ·27 | ·24 | trace | ·04 | 4·0 | 43·1 | 1·96 | Grass, brown, long. |
| | | Dec., 1934 | ·13 | ·35 | ·29 | 1·43 | ·06 | ·64 | 7·1 | 37·8 | 3·44 | Grass, green, long. |
| | | Mar., 1935 | ·10 | ·36 | ·27 | 1·45 | ·22 | ·51 | 6·1 | 33·2 | 3·69 | Grass, mainly green, leafy. |
| | | June, 1935 | ·13 | ·83 | ·34 | 1·05 | ·02 | ·29 | 8·2 | 32·6 | 4·10 | Grass. |
| | | Sept., 1935 | ·057 | ·74 | ·24 | ·64 | ·05 | ·28 | 4·3 | 34·5 | 3·43 | Grass, brown, and bush. |
| **Goedverwachting No. 111** | Zoutpansberg.. | Jan., 1934 | ·16 | 1·01 | ·44 | 2·74 | ·09 | ·43 | 14·2 | 28·6 | 8·02 | Grass, green, and bush. |
| | | April, 1934 | ·12 | ·40 | ·28 | 2·08 | ·07 | ·47 | 9·2 | 36·8 | 4·69 | Grass, long. |
| | | July, 1934 | ·088 | ·55 | ·22 | ·87 | ·04 | ·20 | 5·3 | 39·1 | 2·97 | Grass, mainly brown. |
| | | Oct., 1934 | ·18 | 1·11 | ·31 | 1·52 | ·08 | ·45 | 13·3 | 28·7 | 5·42 | Grass, mainly green, leafy, and bush; mostly bush. |
| | | Jan., 1935 | ·17 | ·43 | ·27 | 2·08 | ·09 | ·57 | 11·0 | 35·2 | 4·53 | Grass, green, long. |
| | | April, 1935 | ·12 | ·65 | ·38 | 1·43 | ·05 | ·69 | 9·1 | 29·7 | 4·44 | Grass, mainly green, leafy. |
| | | July, 1935 | ·069 | ·43 | ·17 | ·55 | ·19 | ·39 | 4·9 | 40·7 | 2·50 | Grass, mainly brown. |
| | | Oct., 1935 | ·076 | 1·18 | ·21 | ·47 | ·03 | ·15 | 6·3 | 35·0 | 8·45 | Grass, brown, and bush. |
| **Municipal Town Lands Louis Trichardt** | Zoutpansberg.. | Nov., 1933 | ·35 | ·44 | ·22 | 2·87 | ·26 | ·62 | 14·5 | 27·2 | 6·30 | Grass, mainly green. |
| | | Feb., 1934 | ·23 | ·25 | ·16 | 1·99 | ·23 | ·95 | 9·8 | 37·0 | 5·07 | Grass, mainly green. |
| | | May, 1934 | ·14 | ·35 | ·20 | 1·67 | ·30 | 1·24 | 6·7 | 34·0 | 4·48 | Grass, mainly green. |
| | | Aug., 1934 | ·15 | ·33 | ·13 | ·50 | ·01 | ·06 | 3·2 | 37·6 | 2·19 | Grass, brown. |
| | | Dec., 1934 | ·26 | ·35 | ·15 | 2·46 | ·33 | 1·32 | 13·8 | 31·3 | 6·50 | Grass, green, leafy. |
| | | Feb., 1935 | ·31 | ·36 | ·14 | 2·12 | ·33 | ·77 | 9·4 | 33·0 | 6·24 | Grass, green, leafy. |
| | | May, 1935 | ·12 | ·22 | ·11 | ·72 | ·03 | ·31 | 3·4 | 38·0 | 2·12 | Grass, mainly brown. |
| | | Aug., 1935 | ·13 | ·26 | ·10 | ·97 | ·03 | ·29 | 2·8 | 41·9 | 2·48 | Grass, brown. |

## AREA 10 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Garth No. 460... | Zoutpansberg.. | Dec., 1933 | ·18 | ·34 | ·25 | 3·11 | ·51 | 1·73 | 9·8 | 27·9 | 7·53 | Grass, green. |
| | | Mar., 1934 | ·13 | ·34 | ·24 | 1·62 | ·24 | ·67 | 9·2 | 35·9 | 4·02 | Grass, mainly green. |
| | | June, 1934 | ·072 | ·42 | ·28 | 1·23 | ·26 | ·55 | 5·7 | 34·8 | 3·58 | Grass. |
| | | Sept., 1934 | ·06 | ·27 | ·23 | ·22 | ·14 | ·34 | 5·9 | 35·7 | 2·28 | Grass, brown. |
| | | Dec., 1934 | ·12 | ·98 | ·41 | 1·67 | ·09 | ·16 | 15·9 | 26·0 | 6·87 | Bush. |
| | | Mar., 1935 | ·14 | ·33 | ·31 | 1·33 | ·44 | ·04 | 11·4 | 29·2 | 5·08 | Grass, green, short. |
| | | June, 1935 | ·17 | ·37 | ·21 | 1·18 | ·22 | ·39 | 11·3 | 28·2 | 3·63 | Grass. |
| | | Sept., 1935 | ·10 | ·86 | ·28 | 1·23 | ·34 | ·30 | 7·7 | 35·6 | 4·83 | Grass, short, and bush. |
| Outlook No. 341. | Zoutpansberg.. | Jan., 1934 | ·22 | ·26 | ·13 | 2·54 | ·15 | ·71 | 11·0 | 40·2 | 5·26 | Grass, green. |
| | | April, 1934 | ·36 | ·24 | ·13 | 1·59 | ·06 | ·36 | 6·2 | 36·3 | 3·36 | Grass, mainly green, short. |
| | | July, 1934 | ·058 | ·27 | ·12 | ·40 | ·03 | ·16 | 3·4 | 36·9 | 1·60 | Grass, mainly brown. |
| | | Oct., 1934 | ·21 | ·30 | ·18 | 1·47 | ·14 | ·44 | 8·8 | 37·1 | 3·60 | Grass, leafy. |
| | | Jan., 1935 | ·13 | ·21 | ·19 | 1·16 | ·07 | ·73 | 6·7 | 36·9 | 2·63 | Grass, green, leafy. |
| | | April, 1935 | ·28 | ·31 | ·14 | 1·60 | ·11 | ·52 | 9·9 | 30·9 | 3·93 | Grass, mainly green, leafy. |
| | | July, 1935 | ·10 | ·32 | ·13 | ·68 | ·06 | ·26 | 3·7 | 43·8 | 2·07 | Grass, mainly brown. |
| | | Oct., 1935 | ·05 | ·18 | ·08 | ·32 | ·03 | ·09 | 4·0 | 38·5 | 1·31 | Grass, brown, leafy. |
| Verzameling van Waters, No. 119 | Zoutpansberg.. | Nov., 1933 | ·25 | ·31 | ·28 | 1·96 | ·34 | ·50 | 11·0 | 33·8 | 4·78 | Grass, green. |
| | | Feb., 1934 | ·21 | ·24 | ·19 | 1·45 | ·04 | ·34 | 4·4 | 40·4 | 3·07 | Grass. |
| | | May, 1934 | ·32 | ·27 | ·16 | 1·07 | ·04 | ·23 | 4·9 | 39·7 | 3·42 | Grass. |
| | | Aug., 1934 | ·18 | ·23 | ·20 | ·51 | ·14 | ·15 | 2·6 | 42·6 | 2·16 | Grass, brown, long. |
| | | Feb., 1935 | ·20 | ·23 | ·13 | 1·39 | ·05 | ·44 | 4·4 | 41·9 | 3·04 | Grass, green, long. |
| | | May, 1935 | ·15 | ·27 | ·16 | ·78 | ·04 | ·18 | 3·1 | 38·0 | 2·16 | Grass, long. |
| | | Aug., 1935 | ·15 | ·23 | ·14 | ·59 | ·05 | ·20 | 2·1 | 41·7 | 1·83 | Grass, brown, long. |
| Laasgevonden No. 74 | Zoutpansberg.. | Dec., 1933 | ·14 | ·24 | ·15 | 1·72 | ·19 | ·38 | 6·2 | 39·5 | 3·62 | Grass, green. |
| | | Mar., 1934 | ·13 | ·25 | ·18 | 1·25 | ·04 | ·28 | 4·4 | 38·4 | 2·81 | Grass, mainly green. |
| | | June, 1934 | ·24 | ·31 | ·23 | ·86 | ·15 | ·28 | 3·8 | 39·2 | 2·95 | Grass, long. |
| | | Sept., 1934 | ·15 | ·27 | ·23 | ·41 | ·19 | ·17 | 2·7 | 43·2 | 1·89 | Grass, brown, long. |
| | | Mar., 1935 | ·11 | ·75 | ·24 | 1·83 | ·08 | ·47 | 5·3 | 39·3 | 4·68 | Grass, long, and bush; mostly grass. |
| | | June, 1935 | ·088 | ·22 | ·11 | ·40 | trace | ·15 | 2·3 | 43·9 | 1·42 | Grass, brown, long. |
| | | Sept., 1935 | ·10 | ·25 | ·14 | ·66 | ·06 | ·26 | 2·0 | 41·6 | 2·55 | Grass, brown, long. |
| Weltevrede....... | Zoutpansberg.. | Jan., 1934 | ·28 | ·51 | ·28 | 3·15 | ·15 | ·67 | 7·1 | 39·2 | 6·98 | Grass and bush. |
| | | April, 1934 | ·26 | ·26 | ·19 | 1·16 | ·06 | ·39 | 4·1 | 39·1 | 3·13 | Grass, long. |
| | | July, 1934 | ·23 | ·53 | ·16 | ·86 | ·12 | ·31 | 5·9 | 34·6 | 3·31 | Grass, mainly brown, long, and bush. |
| | | Oct., 1934 | ·15 | ·25 | ·11 | ·58 | ·03 | ·18 | 4·8 | 38·2 | 1·90 | Grass, mainly brown, long. |
| | | April, 1935 | ·044 | ·26 | ·13 | ·50 | ·07 | ·22 | 5·1 | 37·3 | 2·73 | Grass, mainly brown, long. |
| | | July, 1935 | ·16 | ·32 | ·11 | ·49 | ·04 | ·08 | 3·0 | 39·7 | 2·40 | Grass, brown, long. |
| | | Oct., 1935 | ·11 | ·32 | ·11 | ·46 | ·04 | ·06 | 2·9 | 44·1 | 3·37 | Grass, brown, long. |

AREA 10 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rondebosch No. 30** | Zoutpansberg.. | Nov., 1933 | ·18 | ·31 | ·17 | 1·07 | ·46 | ·44 | 9·8 | 36·1 | 4·27 | Grass and bush; mostly grass. |
| | | Mar., 1934 | ·12 | ·25 | ·14 | 1·09 | ·22 | ·35 | 6·2 | 34·3 | 2·83 | Grass, mainly green. |
| | | May, 1934 | ·081 | ·76 | ·51 | ·63 | ·10 | ·39 | 5·6 | 33·0 | 3·66 | Grass, mainly brown, and bush; mostly grass. |
| | | Oct., 1934 | ·15 | ·46 | ·27 | 1·31 | ·07 | ·26 | 8·9 | 31·8 | 3·71 | Grass, mainly green, and bush. |
| | | Nov., 1934 | ·093 | ·19 | ·14 | ·65 | ·06 | ·29 | 5·1 | 36·7 | 2·06 | Grass, mainly green. |
| | | Feb., 1935 | ·17 | ·28 | ·20 | 1·69 | ·14 | ·56 | 7·4 | 29·9 | 4·00 | Grass, green, short. |
| | | May, 1935 | ·085 | ·26 | ·19 | ·75 | ·11 | ·22 | 4·7 | 36·7 | 2·78 | Grass, mainly brown, long. |
| | | Aug., 1935 | ·046 | ·33 | ·20 | ·45 | ·08 | ·17 | 3·5 | 41·6 | 2·09 | Grass, brown, long. |
| **Nooitgedacht No. 5** | Zoutpansberg.. | Jan., 1934 | ·21 | ·26 | ·20 | 1·64 | ·36 | ·49 | 8·7 | 34·3 | 4·05 | Grass, mainly green. |
| | | Mar., 1934 | ·16 | ·32 | ·18 | 1·13 | ·12 | ·30 | 5·1 | 37·3 | 3·26 | Grass. |
| | | June, 1934 | ·18 | ·47 | ·21 | ·81 | ·07 | ·19 | 5·1 | 37·9 | 3·03 | Grass, mainly brown, and bush; mostly grass. |
| | | Oct., 1934 | ·097 | ·30 | ·14 | ·57 | ·06 | ·15 | 5·2 | 39·9 | 2·27 | Grass. |
| | | Jan., 1935 | ·16 | ·65 | ·34 | 2·11 | ·56 | ·78 | 11·7 | 30·7 | 6·20 | Grass, green, short, and bush. |
| | | Mar., 1935 | ·12 | ·58 | ·24 | 1·32 | ·24 | ·34 | 8·8 | 31·2 | 4·12 | Grass, mainly green, leafy, and bush; mostly grass. |
| | | June, 1935 | ·087 | ·23 | ·16 | ·73 | ·06 | ·20 | 3·7 | 39·2 | 1·97 | Grass, brown, long. |
| | | Sept., 1935 | ·064 | ·20 | ·12 | ·50 | ·09 | ·31 | 2·4 | 43·4 | 2·12 | Grass, brown, long. |
| **Kutamos Location** | Zoutpansberg.. | Feb., 1934 | ·093 | ·43 | ·25 | 1·67 | ·47 | ·57 | 8·3 | 33·4 | 4·33 | Grass. |
| | | April, 1934 | ·13 | ·44 | ·23 | 1·90 | ·49 | ·28 | 9·4 | 33·2 | 4·74 | Grass. |
| | | July, 1934 | ·071 | ·95 | ·39 | 1·04 | ·25 | ·35 | 8·5 | 29·3 | 5·10 | Grass, brown, and bush. |
| | | Nov., 1934 | ·14 | ·71 | ·36 | 1·53 | ·11 | ·11 | 18·8 | 30·6 | 5·39 | Bush. |
| | | Jan., 1935 | ·14 | ·49 | ·36 | 3·02 | ·38 | ·61 | 16·3 | 27·4 | 6·11 | Grass, green, leafy. |
| | | April, 1935 | ·13 | ·85 | ·33 | 2·38 | ·47 | ·27 | 11·6 | 31·7 | 7·10 | Grass, mainly green, and bush; mostly grass. |
| | | July, 1935 | ·071 | ·37 | ·21 | 1·18 | ·09 | ·07 | 4·4 | 39·1 | 3·27 | Grass, brown, long. |
| | | Oct., 1935 | ·073 | ·33 | ·28 | 1·41 | ·31 | ·26 | 7·1 | 36·7 | 3·41 | Grass, mainly brown. |
| **Vergenoeg.......** | Zoutpansberg.. | Dec., 1933 | ·25 | ·41 | ·27 | 2·05 | ·07 | ·42 | 13·0 | 34·3 | 5·16 | Grass, mainly green, and bush. |
| | | Mar.. 1934 | ·26 | ·36 | ·36 | 1·34 | ·30 | ·38 | 9·2 | 33·6 | 4·25 | Grass and bush; mostly grass. |
| | | Jun., 1934 | ·17 | ·64 | ·23 | 1·27 | ·09 | ·24 | 10·9 | 28·3 | 4·06 | Grass, mainly green, short, and bush; mostly grass. |
| **Goedgevonden No. 214** | Zoutpansberg.. | Jan., 1934 | ·13 | ·30 | ·12 | 1·42 | ·05 | ·33 | 6·8 | 39·8 | 3·21 | Grass. |
| | | April, 1934 | ·10 | ·27 | ·20 | ·82 | ·15 | ·24 | 6·5 | 38·7 | 2·37 | Grass, long. |
| | | July, 1934 | ·049 | ·21 | ·09 | ·18 | ·02 | ·03 | 5·1 | 38·6 | 1·23 | Grass, brown. |
| | | Mar., 1935 | ·09 | ·24 | ·07 | ·39 | ·03 | ·09 | 4·0 | 36·3 | 3·63 | Grass. |

## AREA 10 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M'Pefus Location. | Zoutpansberg.. | Feb., 1934 | ·12 | ·88 | ·40 | 1·34 | ·28 | ·40 | 12·0 | 32·3 | 5·80 | Grass, mainly green, and bush; mostly grass. |
| | | May. 1934 | ·076 | ·50 | ·37 | ·79 | ·16 | ·40 | 7·1 | 35·3 | 3·06 | Grass and bush; mostly grass. |
| | | Aug., 1934 | ·085 | ·98 | ·44 | ·77 | ·20 | ·32 | 7·4 | 31·3 | 4·40 | Grass, brown, and bush; mostly bush. |
| | | April, 1935 | ·066 | ·55 | ·28 | 1·15 | ·19 | ·34 | 8·8 | 31·7 | 5·20 | Grass. |
| Woodlands No. 1019 | Zoutpansberg.. | Dec., 1933 | ·14 | 1·29 | ·31 | 2·31 | ·05 | ·41 | 12·0 | 29·7 | 7·72 | Grass, mainly green, and bush. |
| | | Mar., 1934 | ·11 | ·99 | ·32 | 1·81 | ·04 | ·38 | 11·3 | 34·4 | 5·94 | Grass and bush. |
| | | June, 1934 | ·064 | ·49 | ·15 | ·95 | ·07 | ·33 | 4·8 | 36·7 | 3·03 | Grass, brown, and bush; mostly grass. |
| | | Sept., 1934 | ·063 | ·44 | ·11 | ·85 | ·04 | ·16 | 4·7 | 39·6 | 2·21 | Grass, brown, and bush; mostly grass. |
| | | Dec., 1934 | ·078 | ·91 | ·24 | 1·12 | ·08 | ·23 | 10·3 | 38·3 | 4·64 | Grass, mainly green, and bush; mostly bush. |
| | | Oct., 1935 | ·078 | 1·20 | ·48 | 1·50 | ·06 | ·14 | 11·8 | 23·3 | 7·62 | Bush. |
| Durham No. 922. | Zoutpansberg.. | Jan., 1934 | ·13 | ·83 | ·15 | 1·79 | ·05 | ·23 | 8·6 | 34·5 | 4·98 | Grass, mainly green, and bush; mostly grass. |
| | | April, 1934 | ·088 | ·97 | ·18 | 1·26 | ·04 | ·23 | 6·2 | 34·0 | 4·30 | Grass, mainly brown, and bush. |
| | | July, 1934 | ·084 | ·30 | ·13 | 1·02 | ·03 | ·21 | 5·3 | 35·8 | 2·32 | Grass, brown, and bush; mostly grass. |
| | | Oct., 1934 | ·039 | ·13 | ·08 | ·36 | trace | ·09 | 2·7 | 39·2 | 1·12 | Grass, brown, long. |
| | | Jan., 1935 | ·039 | ·26 | ·09 | ·29 | ·01 | ·19 | 3·2 | 39·8 | 1·44 | Grass, brown, and bush; mostly grass. |
| | | Sept., 1935 | ·072 | ·78 | ·13 | ·46 | — | ·12 | 5·4 | 32·9 | 3·19 | Grass, brown, and bush. |
| Mattray No. 686. | Zoutpansberg.. | Jan., 1934 | ·11 | ·25 | ·14 | 1·59 | ·02 | ·37 | 9·1 | 39·1 | 3·25 | Grass. |
| | | April, 1934 | ·087 | ·41 | ·14 | 1·22 | ·04 | ·30 | 5·8 | 33·0 | 2·77 | Grass and bush; mostly grass. |
| | | July' 1934 | ·11 | ·40 | ·13 | ·99 | ·01 | ·33 | 4·4 | 32·6 | 2·63 | Grass, brown, and bush; mostly grass. |
| | | Oct., 1934 | ·071 | ·38 | ·09 | ·78 | ·03 | ·18 | 4·0 | 34·8 | 2·20 | Grass, brown, and bush; mostly grass. |
| | | Jan., 1935 | ·08 | ·43 | ·13 | 1·01 | ·06 | ·17 | 7·1 | 35·1 | 2·72 | Grass, brown, and bush; mostly grass. |
| | | April, 1935 | ·11 | ·48 | ·16 | 1·19 | ·02 | ·27 | 7·9 | 28·9 | 3·12 | Grass and bush; mostly grass. |
| | | Oct., 1935 | ·057 | ·18 | ·08 | ·55 | ·02 | ·05 | 3·9 | 41·5 | 3·17 | Grass, brown, long, and bush; mostly grass. |
| Goosen No. 1071 (Messina) | Zoutpansberg.. | Nov., 1933 | ·15 | 1·25 | ·25 | 1·50 | ·03 | ·27 | 6·8 | 39·6 | 6·43 | Grass, brown, and bush. |
| | | Feb., 1934 | ·15 | 1·35 | ·31 | 2·33 | ·03 | ·43 | 8·1 | 34·5 | 8·06 | Grass, mainly green, and bush. |
| | | May, 1934 | ·091 | ·88 | ·15 | 1·08 | ·03 | ·20 | 5·5 | 41·3 | 4·22 | Grass, mainly brown, and bush. |
| | | Aug., 1934 | ·068 | 1·86 | ·43 | ·68 | ·01 | ·07 | 7·1 | 37·2 | 5·93 | Bush. |
| | | Nov., 1934 | ·083 | 1·11 | ·22 | ·64 | ·25 | ·27 | 7·5 | 33·3 | 4·63 | Grass, brown, and bush. |
| | | Feb., 1935 | ·18 | 1·59 | ·31 | 2·07 | ·11 | ·28 | 17·2 | 21·8 | 7·96 | Bush. |

AREA 10 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vrienden No. 1066 (Messina) | Zoutpansberg.. | Nov., 1933 | ·11 | ·54 | ·22 | 1·18 | ·04 | ·25 | 6·0 | 39·7 | 3·22 | Grass, long. |
| | | Feb., 1934 | ·19 | ·73 | ·22 | 2·43 | ·05 | ·43 | 6·9 | 39·2 | 5·54 | Grass, mainly green. |
| | | May, 1934 | ·19 | ·46 | ·15 | ·95 | ·02 | ·14 | 4·1 | 34·9 | 2·78 | Grass, mainly brown, long, and bush; mostly grass. |
| | | Aug., 1934 | ·20 | ·37 | ·17 | 1·05 | ·03 | ·11 | 4·2 | 37·5 | 2·91 | Grass, brown, long, and bush; mostly grass. |
| | | Nov., 1934 | ·11 | ·32 | ·15 | ·95 | ·07 | ·13 | 5·1 | 36·2 | 2·50 | Grass, brown, long, and bush. |
| | | Feb., 1935 | ·11 | ·59 | ·13 | 1·01 | ·04 | ·27 | 7·4 | 34·3 | 3·13 | Grass and bush; mostly grass. |
| | | May, 1935 | ·13 | ·47 | ·10 | ·73 | ·02 | ·04 | 4·9 | 33·7 | 2·60 | Grass, mainly brown, and bush. |
| | | Aug., 1935 | ·11 | ·53 | ·10 | ·53 | ·03 | ·10 | 4·3 | 36·5 | 2·33 | Grass, brown, and bush; mostly grass. |
| Cromer No. 847 (Messina) | Zoutpansberg.. | Dec., 1933 | ·20 | ·73 | ·25 | 1·98 | ·04 | ·37 | 9·9 | 36·4 | 5·54 | Grass, mainly brown, and bush; mostly grass. |
| | | Mar., 1934 | ·20 | 1·05 | ·32 | 1·69 | ·23 | ·36 | 8·0 | 33·2 | 5·84 | Grass, mainly green, and bush; mostly grass. |
| | | June, 1934 | ·12 | 1·02 | ·27 | 1·00 | ·15 | ·25 | 5·9 | 38·0 | 4·96 | Grass, mainly brown, long, and bush. |
| | | Sept., 1934 | ·074 | ·54 | ·22 | 1·18 | ·20 | ·32 | 6·6 | 38·8 | 3·60 | Grass, brown, long, and bush. |
| | | Dec., 1934 | ·14 | ·50 | ·13 | 1·46 | ·17 | ·34 | 9·8 | 36·3 | 3·81 | Grass, mainly green, long, and bush; mostly grass. |
| | | Mar., 1935 | ·13 | ·66 | ·42 | 1·11 | ·51 | ·62 | 9·5 | 31·5 | 4·75 | Grass, mainly green, and bush. |
| | | June, 1935 | ·11 | ·58 | ·24 | ·74 | ·02 | ·27 | 5·3 | 38·8 | 3·30 | Grass, brown, long. |
| | | Sept., 1935 | ·072 | ·40 | ·26 | ·79 | ·30 | ·42 | 6·4 | 39·6 | 3·23 | Grass, mainly brown, and bush; mostly grass. |
| Rosentawitch (Messina) | Zoutpansberg.. | Nov., 1933 | ·13 | ·20 | ·08 | ·24 | trace | ·06 | 6·7 | 36·1 | 2·52 | Grass, brown, and bush; mostly grass. |
| | | Feb., 1934 | ·11 | ·34 | ·22 | 2·17 | ·03 | ·54 | 4·6 | 37·4 | 4·25 | Grass, mainly green. |
| | | June, 1934 | ·20 | ·74 | ·19 | 1·65 | ·06 | ·40 | 4·7 | 37·8 | 5·14 | Grass, brown, and bush; mostly grass. |
| | | Sept., 1934 | ·11 | ·94 | ·14 | 1·23 | ·04 | ·23 | 5·5 | 36·7 | 4·46 | Grass, brown, and bush; mostly grass. |
| | | Jan., 1935 | ·14 | 1·08 | ·20 | 1·01 | ·02 | ·19 | 7·5 | 33·4 | 4·53 | Grass, brown, short, and bush. |
| Dover No. 819 (Messina) | Zoutpansberg.. | Dec., 1933 | — | ·54 | ·31 | 3·35 | ·20 | — | 9·9 | 34·2 | 7·20 | Grass, green. |
| | | Mar., 1934 | ·13 | ·39 | ·25 | 2·38 | ·26 | ·63 | 8·2 | 35·3 | 6·00 | Grass, mainly green. |
| | | May, 1934 | ·11 | ·59 | ·26 | 1·52 | ·07 | ·30 | 4·8 | 37·5 | 3·86 | Grass, mainly brown. |
| | | May, 1935 | ·12 | 1·55 | ·45 | 1·10 | ·18 | ·25 | 10·3 | — | 6·74 | Bush |

## AREA 10 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Te Velde (Messina) | Zoutpansberg.. | Jan., 1934 | ·15 | ·35 | ·17 | 2·21 | ·04 | ·37 | 7·5 | 38·3 | 5·40 | Grass, mainly green. |
| | | April, 1934 | ·13 | ·44 | ·23 | 1·91 | ·10 | ·43 | 4·9 | 36·2 | 4·49 | Grass, leafy, and bush; mostly grass. |
| | | Oct., 1934 | ·12 | ·62 | ·19 | — | ·06 | ·36 | 3·8 | 31·4 | 3·45 | Grass, brown, long, and bush; mostly grass. |
| | | April, 1935 | ·11 | 1·45 | ·19 | ·96 | ·06 | ·44 | 9·2 | 31·0 | 5·34 | Grass, mainly brown, and bush. |
| Joan No. 1142, (Messina) | Zoutpansberg.. | Nov., 1933 | ·13 | ·37 | ·14 | ·95 | ·18 | ·39 | 7·9 | 38·0 | 3·11 | Grass, brown, and bush; mostly grass. |
| | | Feb., 1934 | ·068 | ·33 | ·23 | ·96 | ·26 | ·38 | 6·4 | 35·7 | 2·88 | Grass, mainly brown. |
| | | May, 1934 | ·061 | ·42 | ·13 | ·69 | ·01 | ·20 | 5·2 | 35·1 | 2·12 | Grass, mainly brown. |
| Ziska No. 1209 (Messina) | Zoutpansberg.. | Dec., 1933 | ·12 | ·81 | ·13 | 1·55 | ·02 | ·26 | 7·5 | 38·7 | 4·46 | Grass and bush; mostly grass. |
| | | Mar., 1934 | ·17 | 1·00 | ·30 | 1·71 | ·10 | ·51 | 6·9 | 39·4 | 6·15 | Grass and bush. |
| | | June, 1934 | ·19 | ·91 | ·34 | 1·02 | ·28 | ·51 | 9·5 | 29·1 | 5·66 | Grass, mainly brown, and bush; mostly bush. |
| Hogeveld No. 1289 (Messina) | Zoutpansberg.. | Jan., 1934 | ·23 | ·74 | ·42 | 2·58 | ·18 | ·77 | 11·0 | 34·8 | 7·38 | Grass, mainly green, and bush; mostly grass. |
| | | April, 1934 | ·099 | 1·82 | ·32 | 1·18 | ·08 | ·24 | 9·2 | 31·7 | 6·46 | Grass and bush; mostly bush. |

## AREA 11.

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hollandsdrift No. 113 | Pietersburg.... | Jan., 1934 | ·17 | ·36 | ·21 | 1·89 | ·12 | ·35 | 9·0 | 31·6 | 4·65 | Grass, mainly green. |
| | | April, 1934 | ·11 | ·31 | ·12 | ·64 | ·02 | ·12 | 3·9 | 34·4 | 1·84 | Grass, mainly brown, leafy. |
| | | July, 1934 | ·046 | ·25 | ·11 | ·20 | trace | ·02 | 2·5 | 36·0 | 1·27 | Grass, brown. |
| | | Mar., 1935 | ·16 | ·29 | ·17 | 1·47 | trace | ·27 | 9·4 | 32·3 | 2·99 | Grass, green, leafy. |
| | | Sept., 1935 | ·098 | ·30 | ·12 | ·66 | ·11 | ·38 | 3·0 | 37·2 | 2·16 | Grass, brown, leafy. |
| Bultfontein No. 1537 | Pietersburg ... | Nov., 1933 | ·10 | ·36 | ·15 | 1·22 | ·08 | ·16 | 6·3 | 39·5 | 3·02 | Grass. |
| | | Feb., 1934 | ·096 | ·24 | ·11 | 1·17 | ·02 | ·21 | 5·4 | 38·4 | 2·75 | Grass, mainly green. |
| | | May, 1934 | ·092 | ·52 | ·19 | 1·29 | ·03 | ·22 | 4·9 | 38·5 | 3·93 | Grass, mainly brown, and bush; mostly grass. |
| | | Aug., 1934 | ·045 | ·20 | ·08 | ·64 | trace | ·05 | 2·3 | 42·2 | 1·49 | Grass, brown, long. |
| | | April, 1935 | ·097 | ·22 | ·10 | 1·07 | trace | ·65 | 5·7 | 35·5 | 2·13 | Grass, mainly brown, long |
| | | July, 1935 | ·052 | ·25 | ·10 | ·59 | ·03 | ·12 | 2·7 | 42·8 | 2·93 | Grass, brown. |
| Chloe............ | Pietersburg.... | Dec., 1933 | ·17 | ·21 | ·16 | 2·01 | ·08 | ·60 | — | 42·5 | 4·21 | Grass, long. |
| | | June, 1934 | ·14 | ·35 | ·20 | ·82 | ·13 | ·58 | 4·7 | 40·5 | 2·82 | Grass, brown, long. |
| | | Sept., 1934 | ·028 | ·19 | ·05 | ·13 | ·04 | ·05 | 3·2 | 38·2 | 2·62 | Grass, brown, long. |
| | | Mar., 1935 | ·08 | ·23 | ·11 | 1·14 | ·03 | ·19 | 6·3 | 36·9 | 2·34 | Grass, mainly green, long. |
| | | June, 1935 | ·087 | ·21 | ·10 | ·98 | ·02 | ·22 | 4·6 | 34·8 | 2·16 | Grass, mainly brown. |
| | | Oct., 1935 | ·038 | ·19 | ·06 | ·22 | ·04 | ·02 | 3·2 | 41·4 | 1·25 | Grass, brown, long. |
| Mountain View... | Pietersburg.... | Jan., 1934 | ·29 | ·57 | ·25 | 3·60 | ·13 | ·58 | 14·6 | 29·3 | 7·92 | Grass, green, leafy. |
| | | July, 1934 | ·16 | ·46 | ·22 | 1·78 | ·10 | ·55 | 7·4 | 33·6 | 4·37 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·056 | ·26 | ·13 | ·49 | ·05 | ·17 | 3·5 | 35·6 | 1·78 | Grass, brown, long. |
| | | May, 1935 | ·15 | ·48 | ·29 | 2·11 | ·27 | ·80 | 7·0 | 34·1 | 5·07 | Grass. |
| | | Aug., 1935 | ·067 | ·27 | ·16 | ·47 | ·03 | ·20 | 3·1 | 38·1 | 2·46 | Grass, brown. |
| Kalkfontein No. 123 | Pietersburg.... | Nov., 1933 | ·15 | ·29 | ·16 | 1·45 | ·46 | ·52 | 8·7 | 31·3 | 4·06 | Grass. |
| | | Feb., 1934 | ·14 | ·34 | ·18 | 1·76 | ·34 | ·98 | 6·7 | 33·7 | 4·89 | Grass, mainly green. |
| | | May, 1934 | ·11 | ·36 | ·20 | ·87 | ·28 | ·63 | 4·4 | 33·9 | 3·32 | Grass. |
| | | Aug., 1934 | ·057 | ·39 | ·16 | ·64 | ·06 | ·16 | 3·3 | 35·3 | 2·28 | Grass, brown. |
| | | Oct., 1934 | ·054 | ·28 | ·13 | ·29 | ·08 | ·12 | 2·7 | 36·8 | 1·82 | Grass, brown. |
| | | Dec., 1934 | ·17 | ·34 | ·14 | 2·25 | ·39 | ·93 | 8·8 | 32·5 | 5·55 | Grass, mainly green, leafy. |
| | | Mar., 1935 | ·21 | ·34 | ·19 | 1·82 | ·30 | ·63 | 7·3 | 32·8 | 4·50 | Grass, green, leafy. |
| | | June, 1935 | ·10 | ·41 | ·16 | ·51 | ·17 | ·31 | 3·4 | 35·7 | 3·38 | Grass, brown, short. |
| Panplaats No.1959 | Pietersburg.... | Dec., 1933 | ·20 | ·82 | ·42 | 3·75 | ·20 | ·78 | 14·0 | 32·3 | 8·38 | Grass, green, and bush. |
| | | Mar., 1934 | ·13 | ·57 | ·22 | 1·46 | ·07 | ·37 | 9·0 | 40·3 | 4·16 | Grass and bush; mostly grass. |
| | | June, 1934 | ·049 | ·30 | ·09 | ·75 | ·09 | ·29 | 4·4 | 35·4 | 2·25 | Grass, brown. |
| | | Sept., 1934 | ·025 | ·17 | ·07 | ·31 | ·03 | ·08 | 3·9 | 38·1 | 2·43 | Grass, brown. |
| | | April, 1935 | ·11 | ·17 | ·12 | 1·11 | ·05 | ·16 | 7·2 | 36·0 | 2·27 | Grass, green, long. |
| | | July, 1935 | ·068 | ·30 | ·18 | ·83 | ·05 | ·27 | 5·6 | 36·9 | 5·32 | Grass, brown. |

## AREA 11 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Potsdam**......... | Pietersburg.... | Jan., 1934 | ·23 | ·69 | ·32 | 3·60 | ·19 | ·81 | 13·6 | 27·2 | 7·92 | Grass, green. |
| | | April, 1934 | ·13 | ·31 | ·19 | 1·94 | ·14 | ·62 | 7·5 | 37·1 | 4·44 | Grass, mainly green. |
| | | July, 1934 | ·047 | ·26 | ·15 | 1·43 | ·04 | ·53 | 4·5 | 42·1 | 2·97 | Grass, brown. |
| | | Nov., 1934 | ·067 | ·33 | ·14 | ·67 | ·13 | ·33 | 4·3 | 38·1 | 2·59 | Grass, brown, leafy. |
| | | Feb., 1935 | ·15 | ·40 | ·27 | 2·40 | ·04 | ·81 | 11·4 | 35·5 | 5·68 | Grass, green. |
| | | May, 1935 | ·17 | ·27 | ·13 | ·90 | ·12 | ·26 | 5·5 | 33·5 | 2·54 | Grass, mainly green. |
| **Kleinfontein**...... | Pietersburg.... | Nov., 1933 | ·16 | ·32 | ·17 | 2·85 | ·38 | ·68 | 10·0 | 37·0 | 5·37 | Grass, green. |
| | | Feb., 1934 | ·12 | ·38 | ·26 | 1·74 | ·56 | ·96 | 8·1 | 35·8 | 4·91 | Grass, mainly green. |
| | | Sept., 1934 | ·11 | ·25 | ·08 | ·49 | ·03 | ·20 | 3·8 | 40·1 | 1·56 | Grass, brown. |
| | | Mar., 1935 | ·13 | ·31 | ·17 | 1·35 | ·05 | ·51 | 5·9 | 38·2 | 2·92 | Grass, green, long. |
| **Voorspoed No. 57** | Pietersburg.... | Mar., 1934 | ·13 | ·33 | ·12 | 1·09 | ·04 | ·31 | 5·8 | 37·9 | 2·67 | Grass, mainly green. |
| **Vygeboomskop**... | Pietersburg.... | Aug., 1934 | ·062 | ·28 | ·17 | ·20 | ·18 | ·18 | 3·4 | 39·4 | 1·49 | Grass, brown, leafy. |
| | | Nov., 1934 | ·062 | ·24 | ·08 | ·33 | ·02 | ·13 | 4·7 | 40·9 | 1·38 | Grass, brown, long. |
| | | April, 1935 | ·13 | ·33 | ·19 | 1·47 | ·24 | ·71 | 6·5 | 36·9 | 3·59 | Grass, green, long. |
| | | June, 1935 | ·07 | ·33 | ·12 | ·30 | ·02 | ·10 | 3·1 | 41·6 | 1·66 | Grass, brown. |
| **Blaauwkrans No. 598** | Pietersburg.... | Nov., 1933 | ·16 | ·50 | ·24 | 1·79 | ·05 | ·43 | 12·5 | 32·0 | 4·51 | Grass, mainly green, and bush. |
| | | Feb., 1934 | ·088 | ·87 | ·27 | 1·14 | ·03 | ·40 | 7·3 | 32·8 | 4·54 | Grass, green, and bush; mostly grass. |
| | | May, 1934 | ·041 | ·65 | ·23 | ·61 | ·01 | ·14 | 4·4 | 34·3 | 2·65 | Grass, mainly brown, leafy. |
| | | Oct., 1934 | ·26 | ·43 | ·37 | 2·59 | ·12 | ·39 | 16·6 | 21·2 | 7·70 | Grass, green, short and bush. |
| | | Mar., 1935 | ·11 | ·63 | ·15 | 1·17 | ·03 | ·23 | 8·3 | 33·1 | 3·35 | Grass, mainly green, leafy, and bush. |
| | | Sept., 1935 | ·098 | ·65 | ·27 | 1·12 | ·05 | ·23 | 9·5 | 25·0 | 3·91 | Grass, brown, and bush; mostly bush. |
| **De Beers**........ | Pietersburg.... | Dec., 1933 | ·16 | ·63 | ·32 | 2·06 | ·06 | ·39 | 11·7 | 31·7 | 5·24 | Grass, green. |
| | | Mar., 1934 | ·092 | ·86 | — | 1·39 | ·02 | ·27 | 7·6 | 27·6 | 4·50 | Grass, mainly green, and bush. |
| | | June, 1934 | ·067 | 1·38 | ·25 | ·80 | ·02 | ·19 | 7·7 | 29·7 | 5·31 | Grass, brown, leafy, and bush. |
| | | Sept., 1934 | ·061 | ·86 | ·22 | ·69 | ·12 | ·21 | 6·5 | 37·2 | 3·46 | Grass, brown, and bush; mostly grass. |
| | | Dec., 1934 | ·099 | ·99 | ·28 | 2·00 | ·03 | ·50 | 11·0 | 32·8 | 5·48 | Grass, green, short, and bush; mostly grass. |
| | | July, 1935 | ·066 | ·84 | ·21 | 1·01 | ·05 | ·09 | 6·5 | 32·1 | 3·91 | Grass, brown, leafy, and bush. |
| **Inkoms**.......... | Pietersburg.... | Jan., 1934 | ·17 | ·42 | ·18 | 1·83 | ·06 | ·33 | 8·6 | 34·2 | 4·11 | Grass, mainly green. |
| | | April, 1934 | ·11 | 1·30 | ·54 | 2·11 | ·12 | ·81 | 9·8 | 25·5 | 8·10 | Grass, mainly green, and bush; mostly grass. |
| | | Aug., 1934 | ·075 | 2·04 | ·60 | ·94 | ·03 | ·09 | 7·7 | 36·6 | 7·30 | Bush. |
| | | Nov., 1934 | ·38 | ·64 | ·36 | 4·24 | ·25 | ·66 | 18·8 | 24·0 | 9·06 | Grass, green, short. |
| | | Feb., 1935 | ·20 | — | — | — | ·68 | ·50 | 15·4 | 29·3 | 6·96 | Grass, green, leafy, and bush. |
| | | May, 1935 | ·13 | ·89 | ·40 | 1·65 | ·18 | ·32 | 9·5 | 31·3 | 5·40 | Grass. |
| | | Aug., 1935 | ·15 | ·62 | ·25 | 1·31 | ·05 | ·10 | 12·1 | 30·2 | 4·05 | Grass, brown, and bush. |

## AREA 11 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Modderfontein No. 221** | Pietersburg.... | Nov., 1933 | ·095 | ·20 | ·13 | ·88 | ·47 | ·37 | 8·8 | 36·0 | 3·08 | Grass. |
| | | Feb., 1934 | ·13 | ·28 | ·14 | 1·16 | ·31 | ·45 | 7·3 | 35·5 | 3·17 | Grass, mainly green. |
| | | May, 1934 | ·17 | ·35 | ·12 | ·65 | ·12 | ·15 | 5·0 | 35·6 | 2·47 | Grass, mainly brown. |
| | | Aug., 1934 | ·063 | ·28 | ·10 | ·25 | ·03 | ·04 | 3·7 | 36·7 | 1·32 | Grass, brown. |
| **Droogeloop No.848** | Pietersburg.... | Dec., 1933 | ·31 | ·26 | ·23 | 2·65 | ·32 | ·69 | 13·7 | 33·2 | 5·72 | Grass, green. |
| | | Mar., 1934 | ·099 | ·37 | ·15 | ·75 | ·14 | ·38 | 7·2 | 34·8 | 3·37 | Grass. |
| | | June, 1934 | ·13 | ·35 | ·09 | ·30 | ·06 | ·07 | 3·4 | 35·7 | 1·80 | Grass, brown. |
| **Geluk**.......... | Pietersburg.... | Jan., 1934 | ·11 | ·26 | ·14 | 1·73 | ·18 | ·35 | 6·8 | 39·6 | 3·34 | Grass, mainly green. |
| | | April, 1934 | ·093 | ·28 | ·10 | 1·21 | ·33 | ·25 | 5·5 | 33·6 | 2·44 | Grass, mainly green. |
| | | July, 1934 | ·039 | ·32 | ·12 | ·45 | ·04 | ·12 | 3·0 | 34·3 | 1·46 | Grass, brown, leafy. |
| **Danzig No. 1074.** | Pietersburg.... | Nov., 1933 | ·15 | ·50 | ·22 | 1·84 | ·20 | ·47 | 14·0 | 26·7 | 4·93 | Grass, green, short. |
| | | Mar., 1934 | ·097 | ·36 | ·23 | 1·51 | ·13 | ·47 | 6·4 | 33·5 | 3·46 | Grass, mainly green, long. |
| | | Aug., 1934 | ·042 | ·47 | ·19 | — | ·01 | ·06 | 3·8 | 35·4 | 2·76 | Grass, brown. |
| | | Nov., 1934 | ·11 | 2·06 | ·32 | ·68 | ·06 | ·09 | 9·4 | 26·1 | 7·16 | Bush. |
| | | Jan., 1935 | ·12 | ·49 | ·29 | 2·38 | ·04 | ·46 | 10·4 | 29·7 | 4·94 | Grass, mainly green, short, and bush. |
| | | Feb., 1935 | ·16 | ·38 | ·28 | 3·40 | ·33 | ·93 | 13·6 | 32·2 | 6·60 | Grass, green, leafy. |
| | | May, 1935 | ·08 | ·45 | ·12 | ·84 | ·02 | ·15 | 6·4 | 36·6 | 2·76 | Grass, mainly brown. |
| **Westheim No. 983** | Pietersburg.... | Dec., 1933 | ·23 | ·35 | ·31 | 4·15 | ·15 | ·50 | 14·4 | 28·8 | 8·08 | Grass, green, leafy. |
| | | Sept., 1934 | ·035 | ·24 | ·06 | ·27 | trace | ·03 | 4·0 | 36·8 | 1·37 | Grass, brown. |
| | | Dec., 1934 | ·17 | ·73 | ·27 | 2·70 | ·07 | ·54 | 12·5 | 28·3 | 6·74 | Grass, green, leafy, and bush. |
| | | Mar., 1935 | ·16 | ·43 | ·25 | 2·15 | ·03 | ·59 | 11·4 | 35·6 | 4·52 | Grass, green, leafy. |
| | | June, 1935 | ·091 | ·44 | ·15 | ·94 | ·01 | ·23 | 5·4 | 36·9 | 2·70 | Grass, brown. |
| | | Sept., 1935 | ·055 | 1·73 | ·32 | ·52 | ·04 | ·20 | 6·7 | 31·6 | 5·96 | Bush. |
| **Krantzkop**....... | Pietersburg.... | Jan., 1934 | ·17 | ·31 | ·20 | 2·35 | ·46 | ·30 | 10·6 | 36·7 | 4·92 | Grass, mainly green. |
| | | July, 1934 | ·047 | ·66 | ·20 | ·92 | ·02 | ·16 | 9·4 | 38·6 | 3·22 | Grass, brown, and bush. |
| | | Oct., 1934 | ·05 | ·68 | ·12 | ·11 | ·01 | ·01 | 4·4 | 38·5 | 2·64 | Grass, brown, and bush; mostly grass. |
| | | April, 1935 | ·097 | ·49 | ·23 | 2·18 | ·06 | ·64 | 7·4 | 34·2 | 4·82 | Grass. |
| | | July, 1935 | ·13 | ·93 | ·26 | 1·36 | ·08 | ·30 | 10·6 | 27·6 | 6·18 | Grass, brown, and bush; mostly bush. |
| **Welgevonden No. 1510** | Pietersburg.... | Jan., 1934 | ·16 | ·24 | ·20 | 1·54 | ·46 | ·45 | 9·1 | 35·3 | — | Grass, mainly green. |
| | | April, 1934 | ·12 | ·26 | ·18 | ·70 | ·11 | ·24 | 5·4 | 40·3 | 1·97 | Grass. |
| | | July, 1934 | ·082 | ·28 | ·14 | ·38 | ·10 | ·23 | 3·1 | 37·5 | 1·74 | Grass, mainly brown. |
| | | Oct., 1934 | ·065 | ·26 | ·09 | ·29 | ·03 | ·11 | 3·9 | 38·5 | 1·35 | Grass, mainly brown. |
| **Goedehoop No. 785** | Pietersburg.... | Feb., 1934 | ·16 | ·26 | ·20 | 1·66 | ·50 | ·53 | 8·3 | 39·3 | 4·20 | Grass, mainly green. |
| | | May, 1934 | ·071 | ·32 | ·13 | ·64 | ·06 | ·22 | 3·5 | 36·9 | 1·86 | Grass, mainly brown. |
| | | Aug., 1934 | ·06 | ·27 | ·11 | ·23 | ·01 | ·07 | 2·7 | 40·4 | 1·27 | Grass, brown, long. |
| | | Nov., 1934 | ·093 | ·35 | ·14 | ·83 | ·15 | ·28 | 8·0 | 35·8 | 2·60 | Grass, mainly green, long. |

## AREA 11 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Doornhoek No. 1677 | Pietersburg.... | Mar., 1934 | ·079 | ·24 | ·12 | 1·49 | ·32 | ·62 | 4·9 | 37·6 | 3·45 | Grass, mainly green. |
| | | June, 1934 | ·093 | ·28 | ·09 | ·52 | ·04 | ·17 | 3·6 | 36·2 | 1·76 | Grass, mainly brown. |
| | | Sept., 1934 | ·13 | ·25 | ·10 | ·23 | ·03 | ·04 | 1·9 | 43·4 | 1·54 | Grass, brown, long. |
| Doornboom No. 1579 | Pietersburg.... | May, 1934 | ·19 | ·34 | ·14 | 1·33 | ·06 | ·29 | 6·9 | 32·7 | 3·29 | Grass, leafy. |
| | | Aug., 1934 | ·093 | ·34 | ·11 | ·51 | ·01 | ·08 | 3·5 | 39·0 | 1·89 | Grass, mainly brown, leafy. |
| | | Nov., 1934 | ·18 | ·24 | ·15 | 2·36 | ·06 | ·49 | 14·8 | 32·4 | 4·26 | Grass, green, leafy. |
| Brooklands....... | Pietersburg.... | Nov., 1933 | ·17 | ·37 | ·14 | 2·30 | ·05 | ·40 | 10·2 | 32·0 | 5·04 | Grass. |
| | | Feb., 1934 | ·096 | ·24 | ·11 | 1·11 | ·01 | ·23 | 6·0 | 37·0 | 2·73 | Grass, mainly green. |
| | | May, 1934 | ·064 | ·30 | ·12 | ·56 | trace | ·11 | 2·6 | 37·3 | — | Grass, mainly brown, leafy. |
| | | Aug., 1934 | ·029 | ·30 | ·08 | ·17 | trace | ·03 | 2·3 | 43·5 | 1·24 | Grass, brown. |
| | | Dec., 1934 | ·14 | ·20 | ·22 | 1·52 | trace | ·34 | 7·0 | 34·9 | 3·04 | Grass, green, long. |
| | | April, 1935 | ·11 | ·35 | ·17 | 1·19 | ·03 | ·28 | 6·1 | 33·9 | 2·71 | Grass, mainly green, leafy. |
| Roodepoort No. 88 | Pietersburg.... | Dec., 1933 | ·15 | ·30 | ·24 | 2·16 | ·05 | ·34 | 10·8 | 31·8 | 4·42 | Grass, mainly green. |
| | | Mar., 1934 | ·22 | ·31 | ·20 | ·86 | ·04 | ·15 | 4·6 | 35·8 | 2·67 | Grass, mainly green. |
| | | June, 1934 | ·05 | ·19 | ·11 | ·29 | ·01 | ·07 | 3·4 | 35·4 | 1·28 | Grass, mainly brown. |
| | | Sept., 1934 | ·067 | ·26 | ·23 | ·39 | ·02 | ·09 | 4·4 | 34·3 | 1·82 | Grass, mainly brown. |
| | | Feb., 1935 | ·16 | ·35 | ·23 | ·94 | ·10 | ·44 | 9·6 | 31·9 | 4·20 | Grass, mainly green, leafy. |
| | | May, 1935 | ·085 | ·30 | ·14 | 1·07 | ·04 | ·22 | 4·9 | 33·2 | 2·60 | Grass, mainly brown. |
| | | Aug., 1935 | ·072 | ·34 | ·13 | ·54 | ·01 | ·29 | 3·2 | 36·9 | 1·94 | Grass, brown, leafy. |
| Sandfontein, P.O. Boons | Rustenburg.... | Mar., 1934 | ·091 | ·30 | ·17 | 1·88 | ·03 | ·47 | 6·3 | 35·9 | 4·14 | Grass, mainly green, short. |
| | | June, 1934 | ·043 | ·35 | ·10 | ·29 | trace | ·06 | 3·2 | 35·1 | 1·77 | Grass, brown, leafy. |
| | | Sept., 1934 | — | ·30 | ·12 | ·21 | trace | — | 3·0 | 35·3 | 1·72 | Grass, brown, leafy. |
| | | Mar., 1935 | ·11 | ·27 | ·12 | 1·68 | trace | ·45 | 6·0 | 38·7 | 2·72 | Grass, mainly green. |
| | | Sept., 1935 | ·044 | ·23 | ·10 | ·25 | ·06 | ·17 | 4·1 | 36·2 | 1·78 | Grass, brown, short. |
| Diepkloof........ | Zwartruggens... | Jan., 1934 | ·070 | ·22 | ·20 | ·81 | ·02 | ·20 | 5·1 | 39·9 | 2·47 | Grass, mainly brown, short. |
| | | April, 1934 | ·077 | ·25 | ·20 | 1·01 | ·02 | ·24 | 8·0 | 27·3 | 2·74 | Grass, mainly green, short. |
| | | July, 1934 | ·083 | ·25 | ·12 | ·70 | ·02 | ·15 | 3·2 | 31·7 | 2·00 | Grass, mainly brown. |
| | | Oct., 1934 | ·093 | ·14 | ·08 | ·62 | trace | — | 6·7 | 27·7 | 2·31 | Grass, mainly green, short. |
| | | April, 1935 | ·082 | ·25 | ·16 | ·69 | ·07 | ·42 | 6·3 | 31·5 | 2·99 | Grass, short. |
| | | July, 1935 | ·066 | ·24 | ·12 | ·36 | ·01 | ·13 | 5·5 | 37·0 | 1·82 | Grass, brown, short. |
| Wagenboomkop.. | Zwartruggens... | Jan., 1934 | ·14 | ·26 | ·26 | 1·34 | ·03 | ·30 | — | 32·1 | 3·66 | Grass, short. |
| | | April, 1934 | ·11 | ·21 | ·19 | 1·09 | ·02 | ·36 | 7·6 | 28·0 | 2·99 | Grass, mainly green, short. |
| | | July, 1934 | ·04 | ·20 | ·14 | ·30 | trace | ·05 | 5·1 | 36·1 | 1·32 | Grass, mainly brown. |
| | | Oct., 1934 | ·05 | ·27 | ·13 | ·39 | ·02 | ·09 | 4·4 | 35·2 | 1·67 | Grass, mainly green, short. |
| | | April, 1935 | ·08 | ·30 | ·25 | ·51 | ·08 | ·21 | 5·9 | 34·8 | 2·49 | Grass. |
| | | July, 1935 | ·07 | ·29 | ·19 | ·95 | ·05 | ·15 | 4·4 | 37·3 | 2·67 | Grass, brown. |

AREA 11 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kwaggashoek, P.O. Mabaalstad | Rustenburg.... | Jan., 1934 | ·14 | ·26 | ·20 | 1·95 | ·03 | ·36 | 10·4 | 34·6 | 3·98 | Grass, short. |
| | | April, 1934 | ·057 | ·22 | ·15 | ·75 | ·01 | — | 6·8 | 39·8 | 2·21 | Grass, mainly green, short. |
| | | July, 1934 | ·065 | ·32 | ·16 | ·35 | trace | ·06 | 3·8 | 35·5 | 1·75 | Grass, mainly brown. |
| | | Oct., 1934 | ·22 | ·44 | ·26 | ·73 | ·08 | — | 6·2 | — | 2·35 | Grass, green, short, and bush; mostly grass. |
| | | April, 1935 | ·079 | ·26 | ·15 | ·71 | trace | ·30 | 6·3 | 33·1 | 2·85 | Grass, short. |
| | | July, 1935 | ·063 | ·24 | ·12 | ·41 | ·01 | ·12 | 4·5 | 40·5 | 1·76 | Grass, brown, short. |
| Driefontein No. 90 | Marico. ....... | April, 1935 | ·064 | ·28 | ·18 | ·89 | ·07 | ·15 | 5·4 | 30·9 | 2·46 | Grass, green, long. |
| | | July, 1935 | ·093 | ·37 | ·15 | ·73 | ·04 | ·17 | 4·5 | 40·0 | 2·27 | Grass, brown, leafy. |
| | | Nov., 1935 | ·056 | ·25 | ·11 | ·86 | trace | ·17 | 6·1 | 32·9 | 2·18 | Grass, mainly green. |
| Kleinfontein No. 76 | Marico......... | May, 1935 | ·10 | ·28 | ·19 | 1·02 | ·04 | ·24 | 4·2 | 32·1 | 2·75 | Grass. |
| | | Aug., 1935 | ·086 | ·35 | ·19 | 1·03 | trace | ·14 | 2·9 | 39·3 | 2·71 | Grass, brown, leafy. |
| Klaarsboom No. 67, P.O.Vaalkop | Marico......... | June, 1935 | ·10 | ·32 | ·16 | ·85 | trace | ·10 | 4·1 | 40·2 | 2·31 | Grass, brown, leafy. |
| | | Oct., 1935 | ·045 | ·24 | ·12 | ·24 | ·01 | ·04 | 3·9 | 37·5 | 1·45 | Grass, brown. |
| Klippan No. 194, P.O. Slurry | Marico......... | April, 1935 | ·063 | ·46 | ·14 | ·91 | ·02 | ·17 | 5·1 | 35·3 | 3·61 | Grass, mainly green, long. |
| | | July, 1935 | ·068 | ·55 | ·25 | ·99 | ·02 | ·19 | 6·1 | 36·0 | 3·08 | Grass, brown, leafy. |
| | | Oct., 1935 | ·059 | ·49 | ·10 | ·44 | trace | ·05 | 4·1 | 36·4 | 2·22 | Grass, brown, leafy. |
| | | Mar., 1936 | ·09 | ·34 | ·25 | 1·42 | trace | — | 5·4 | 39·9 | 3·48 | Grass. green, leafy. |
| Tweefontein No. 64, P.O. Zeerust | Marico......... | May, 1935 | ·072 | ·47 | ·20 | ·52 | trace | ·11 | 3·9 | 35·6 | 2·05 | Grass, mainly brown, leafy. |
| | | Aug., 1935 | ·070 | ·58 | ·26 | ·28 | ·01 | ·17 | 3·4 | 38·7 | 2·47 | Grass, brown, leafy. |
| | | Nov., 1935 | ·076 | ·35 | ·25 | 1·29 | trace | ·22 | 7·6 | 33·6 | 2·94 | Grass, mainly green, leafy. |
| Gougekregen..... | Marico......... | June, 1935 | ·070 | ·30 | ·15 | ·55 | trace | ·15 | 3·2 | 36·5 | 1·75 | Grass. brown. |
| | | Sept., 1935 | ·056 | ·47 | ·21 | ·47 | trace | ·16 | 4·3 | 38·4 | 2·92 | Grass, brown, leafy. |
| | | Feb., 1936 | ·12 | ·40 | ·32 | 3·79 | trace | ·37 | 11·9 | 33·5 | 7·74 | Grass, green. |
| Middelbult, P.O. Girdan | Lichtenburg.... | April, 1935 | ·20 | ·50 | ·23 | 2·12 | ·04 | ·61 | 10·8 | 29·8 | 4·79 | Grass, mainly green, short. |
| | | Aug., 1935 | ·066 | ·44 | ·28 | ·97 | ·07 | ·07 | 6·0 | 32·8 | 3·27 | Grass, brown. leafy. |
| | | Feb., 1936 | ·17 | ·27 | ·13 | 2·04 | trace | ·47 | 11·5 | 35·1 | 4·31 | Grass, mainly green, and bush mostly grass. |
| Withan.......... | Lichtenburg.... | May, 1935 | ·15 | ·58 | ·16 | 1·13 | ·07 | ·23 | 5·1 | 31·9 | 3·12 | Grass, mainly brown, leafy. |
| | | Jan., 1936 | ·18 | ·59 | ·12 | 1·66 | trace | ·47 | 5·8 | 28·9 | 4·27 | Grass, mainly green, leafy. |
| Makoeiespan, P.O. Bakers | Lichtenburg.... | June, 1935 | ·053 | ·30 | ·10 | ·45 | trace | ·078 | 3·3 | 36·0 | 1·60 | Grass, brown, leafy. |
| | | Sept., 1935 | ·053 | ·27 | ·11 | ·48 | trace | ·13 | 5·7 | 34·0 | 1·90 | Grass, brown. |
| | | Mar., 1936 | ·18 | ·34 | ·16 | 1·65 | trace | ·29 | 11·0 | 35·3 | 3·57 | Grass, green, leafy. |

## AREA 11 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Zandfontein No. 589, P.O. Wevedene | Rustenburg.... | Nov., 1933 | ·18 | ·49 | ·26 | 2·79 | ·08 | ·50 | 11·7 | 25·6 | 5·92 | Grass and bush; mostly grass. |
| | | Feb., 1934 | ·074 | ·22 | ·15 | 1·62 | ·02 | ·35 | 7·9 | 36·9 | 3·38 | Grass, mainly green. |
| | | May, 1934 | ·049 | ·29 | ·14 | 1·00 | ·03 | ·13 | 3·8 | 40·6 | 2·38 | Grass. |
| | | Aug., 1934 | ·065 | ·34 | — | ·72 | trace | ·16 | 4·6 | 37·3 | 2·15 | Grass, mainly brown, short. |
| | | Nov., 1934 | ·097 | ·30 | ·16 | 1·88 | ·13 | ·57 | 9·9 | 30·8 | 4·03 | Grass, mainly green, leafy. |
| | | April, 1935 | ·087 | ·40 | ·12 | ·90 | ·17 | ·26 | 4·6 | 32·5 | 2·93 | Grass, leafy. |
| | | June, 1935 | ·079 | ·46 | ·18 | 1·12 | trace | ·28 | 5·0 | 34·0 | 3·08 | Grass, mainly brown, leafy. |
| | | Sept., 1935 | ·051 | ·30 | ·14 | ·49 | ·03 | ·17 | 4·1 | 35·5 | 2·07 | Grass, brown, short. |
| Leeuwkoppies, P.O. Northam | Rustenburg.... | Dec., 1933 | ·22 | ·68 | ·57 | 1·96 | ·04 | ·55 | 11·2 | 30·0 | 7·00 | Grass, short. |
| Kromdraai No. 692, P.O. Derby | Rustenburg.... | Jan., 1934 | ·23 | ·42 | ·50 | 3·61 | trace | ·61 | 13·8 | 34·0 | 8·06 | Grass, mainly green. |
| | | April, 1934 | ·12 | ·28 | ·18 | 2·06 | ·09 | ·48 | 6·2 | 36·5 | 3·44 | Grass. |
| | | July, 1934 | ·077 | ·49 | ·27 | 1·38 | ·02 | ·53 | 6·1 | 36·4 | 3·64 | Grass, brown, leafy. |
| | | Oct., 1934 | ·068 | ·33 | ·25 | 1·16 | ·09 | ·45 | 6·0 | 36·2 | 3·03 | Grass, brown, leafy.. |
| | | Mar., 1935 | ·28 | ·36 | ·34 | 2·20 | ·38 | ·82 | 7·2 | 39·3 | 5·10 | Grass, mainly green, long. |
| | | July, 1935 | ·05 | ·53 | ·22 | 1·40 | ·04 | ·36 | 4·9 | 39·1 | 3·90 | Grass, mainly brown. |
| Grootkuil, P.O. Northam | Rustenburg.... | Mar., 1934 | ·18 | ·35 | ·21 | 2·16 | ·09 | ·64 | 8·7 | 36·6 | 4·57 | Grass, mainly green. |
| | | June, 1934 | ·17 | ·47 | ·22 | 1·18 | ·16 | ·32 | 6·8 | 37·4 | 3·57 | Grass, mainly brown. |
| Wildebeestlaagte, P.O. Northam | Rustenburg.... | Sept., 1934 | ·09 | ·91 | ·40 | 1·66 | ·04 | ·04 | 5·0 | 36·8 | — | Grass, brown. |
| | | Feb., 1935 | ·18 | ·56 | ·30 | 3·08 | ·56 | 1·19 | 13·4 | 30·6 | 7·33 | Grass, mainly green, leafy. |
| | | May, 1935 | ·12 | ·40 | ·21 | 1·43 | ·13 | ·42 | 6·7 | 29·6 | 3·94 | Grass, mainly brown, leafy. |
| | | Aug., 1935 | ·22 | ·35 | ·15 | 1·35 | trace | ·08 | 3·3 | 41·5 | 3·44 | Grass, brown, leafy. |
| | | Oct., 1935 | ·08 | ·24 | ·08 | ·50 | ·02 | ·06 | 5·2 | 37·6 | 2·40 | Grass, brown, leafy. |
| Buffelspoort, No. 668, P.O. Marikana | Rustenburg.... | Nov., 1933 | ·10 | ·28 | ·17 | ·76 | ·02 | ·20 | 7·8 | 34·6 | 2·79 | Grass, mainly green. |
| | | Feb., 1934 | ·13 | ·33 | ·11 | 1·85 | ·02 | ·12 | 8·7 | 34·2 | 3·66 | Grass, mainly green, short. |
| | | May, 1934 | ·05 | ·51 | ·18 | ·79 | ·02 | ·10 | 4·4 | 32·3 | 3·13 | Grass, mainly brown, short, and bush; mostly grass. |
| | | Aug., 1934 | ·056 | ·22 | ·13 | ·63 | trace | ·10 | 3·9 | 33·2 | 1·83 | Grass, mainly brown, short. |
| | | Nov., 1934 | ·074 | ·37 | ·15 | 1·54 | trace | ·36 | 6·8 | 34·4 | 3·61 | Grass, leafy. |
| | | Feb., 1935 | ·077 | ·29 | ·11 | 1·06 | ·03 | ·26 | 5·8 | 32·2 | 3·46 | — |
| | | May, 1935 | ·062 | ·36 | ·20 | ·59 | ·02 | ·15 | 5·6 | 26·6 | 3·06 | Grass, short. |
| | | Aug., 1935 | ·075 | ·42 | ·15 | ·46 | ·26 | ·13 | 3·6 | 37·7 | 3·03 | Grass, brown, short. |
| Kafferskraal No. 915, P.O. Marikana | Rustenburg.... | Feb., 1934 | ·11 | ·30 | ·32 | 2·07 | ·03 | ·40 | 7·4 | 37·1 | 4·28 | Grass, mainly green. |
| | | May, 1934 | ·063 | ·29 | ·24 | ·58 | ·01 | ·23 | 4·3 | 32·1 | 2·82 | Grass, mainly brown, short. |
| | | Aug., 1934 | ·037 | ·20 | ·17 | ·30 | trace | ·05 | 3·4 | 39·0 | 1·54 | Grass, brown, leafy. |
| | | Nov., 1934 | ·10 | ·45 | ·18 | 1·30 | ·26 | ·62 | 8·9 | 29·3 | 4·02 | Grass, mainly green, short. |
| | | Feb., 1935 | ·12 | ·30 | ·31 | 1·64 | ·03 | ·32 | 8·8 | 33·5 | 3·94 | — |
| | | May, 1935 | ·057 | ·28 | ·19 | ·60 | ·03 | ·15 | 3·8 | 37·5 | 2·31 | Grass, short. |
| | | Aug., 1935 | ·067 | ·31 | ·19 | ·38 | ·14 | ·04 | 2·8 | 33·1 | 2·32 | Grass, mainly brown, short. |

AREA 11 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spruitfontein No. 349, P.O. Marikana | Rustenburg.... | Feb., 1934 | ·12 | ·26 | ·18 | 2·08 | ·02 | ·36 | 6·5 | 33·7 | 3·70 | Grass, mainly green, short. |
| | | May, 1934 | ·069 | ·33 | ·13 | ·75 | ·01 | ·15 | 4·2 | 35·1 | 2·42 | Grass, mainly brown, short. |
| | | Aug., 1934 | ·050 | ·48 | ·13 | ·67 | trace | ·11 | 5·0 | 34·3 | 2·30 | Grass, mainly brown. |
| | | Nov., 1934 | ·083 | ·52 | ·14 | ·81 | ·02 | ·21 | 6·3 | 36·2 | 2·39 | Grass, short. |
| | | Feb., 1935 | ·099 | ·39 | ·22 | 1·09 | ·51 | ·58 | 6·0 | 32·2 | 4·20 | — |
| | | May, 1935 | ·087 | ·27 | ·13 | ·76 | trace | — | 5·0 | 31·1 | 2·64 | Grass, mainly green, short. |
| | | Aug., 1935 | ·058 | ·44 | ·17 | ·57 | ·02 | ·08 | 3·9 | 35·8 | 2·39 | Grass, mainly brown, short. |
| Onverwacht No. 666, P.O. Heldinia | Magaliesberg... | Dec., 1933 | ·07 | ·24 | ·12 | ·86 | ·05 | ·19 | 7·2 | 36·3 | 2·40 | Grass, mainly brown, short. |
| | | Mar., 1934 | ·11 | ·40 | ·30 | 1·33 | ·04 | ·24 | 10·9 | 29·4 | 3·09 | Grass, green, short. |
| | | June, 1934 | ·079 | ·32 | ·18 | ·56 | ·02 | ·15 | 4·0 | 36·0 | 2·36 | Grass. |
| | | Sept., 1934 | ·086 | ·25 | ·16 | ·41 | ·02 | ·19 | 5·6 | 29·9 | 1·88 | Grass, mainly brown, short. |
| | | Mar., 1935 | ·092 | ·32 | ·10 | 1·03 | ·04 | ·28 | 6·6 | 36·5 | 2·85 | Grass, mainly green, short. |
| | | June, 1935 | ·12 | ·49 | ·22 | ·61 | ·05 | ·18 | 5·4 | 32·9 | 3·65 | Grass, mainly brown, short. |
| Cyferfontein, P.O. Cyferbult | Magaliesberg... | Dec., 1933 | ·15 | ·43 | ·16 | 2·17 | ·04 | ·53 | 10·7 | 31·0 | 5·54 | Grass, short. |
| | | Mar., 1934 | ·12 | ·38 | ·20 | 1·72 | ·07 | ·41 | 8·4 | 32·4 | 4·11 | Grass, mainly green, short. |
| | | June, 1934 | ·058 | ·40 | ·18 | 1·12 | trace | ·20 | 6·8 | 32·6 | 3·05 | Grass, short. |
| | | Sept., 1934 | ·043 | ·40 | ·40 | ·58 | ·02 | ·03 | 5·2 | 42·5 | 2·68 | Grass, brown. |
| | | Mar., 1935 | ·093 | ·32 | ·11 | 1·01 | ·02 | ·31 | 5·6 | 32·3 | 3·09 | Grass, mainly green, short. |
| | | June, 1935 | ·21 | ·46 | ·41 | 2·18 | trace | ·67 | 10·8 | 30·8 | 5·45 | Grass, short. |
| | | Sept., 1935 | ·059 | ·45 | ·17 | ·36 | ·15 | ·24 | 4·5 | 33·8 | 2·84 | Grass, brown, short. |
| Klipfontein No. 60 | Witbank....... | Nov., 1933 | ·19 | ·27 | ·11 | 1·87 | ·04 | ·39 | 13·8 | 37·5 | 3·77 | Grass, green. |
| | | Feb., 1934 | ·11 | ·22 | ·19 | 1·09 | ·03 | ·25 | 6·1 | 36·3 | 2·52 | Grass, mainly green. |
| | | May, 1934 | ·078 | ·27 | ·11 | ·82 | ·02 | ·21 | 3·7 | 36·4 | 1·54 | Grass, leafy. |
| | | Aug., 1934 | ·029 | ·24 | ·07 | ·14 | trace | ·01 | 2·8 | 36·7 | 1·16 | Grass, brown, leafy. |
| | | May, 1935 | ·058 | ·22 | ·09 | ·32 | trace | ·07 | 3·2 | 32·8 | 1·42 | Grass, mainly brown, leafy. |
| | | July, 1935 | ·051 | ·24 | ·09 | ·28 | ·01 | ·06 | 2·9 | 35·6 | 1·64 | Grass, brown, short. |
| | | Oct., 1935 | ·042 | ·19 | ·07 | ·29 | ·01 | ·06 | 3·5 | 30·9 | 1·53 | Grass, brown, short. |
| Vlaklaagte No. 71, P.O. Blackhill | Witbank....... | Dec., 1933 | ·11 | ·25 | ·11 | 1·49 | ·03 | ·26 | 8·2 | 41·0 | 3·14 | Grass, mainly green. |
| | | Mar., 1934 | ·074 | ·29 | ·10 | 1·14 | ·02 | ·18 | 5·0 | 37·7 | 2·68 | Grass. |
| | | June, 1934 | ·039 | ·28 | ·09 | ·16 | ·01 | ·02 | 3·5 | 33·9 | 1·46 | Grass, mainly brown, leafy. |
| | | Sept., 1934 | ·043 | ·22 | ·07 | ·15 | ·02 | ·04 | 3·2 | 34·7 | 1·14 | Grass, brown, leafy. |
| | | Mar., 1935 | ·088 | ·25 | ·07 | ·61 | ·07 | ·13 | 6·3 | 32·3 | 2·11 | Grass, leafy. |
| | | Aug., 1935 | ·052 | ·35 | ·12 | ·42 | trace | ·09 | 3·5 | 33·1 | 2·43 | Grass, brown, short. |
| Klipplaat, P.O. Coalville | Witbank....... | Jan., 1934 | ·099 | ·32 | ·20 | 1·51 | ·03 | ·29 | 7·9 | 36·7 | 3·52 | Grass, mainly green. |
| | | April, 1934 | ·088 | ·34 | ·11 | ·62 | ·02 | ·13 | 5·1 | 30·0 | 2·18 | Grass, leafy. |
| | | July, 1934 | ·047 | ·29 | ·07 | ·14 | trace | ·02 | 2·4 | 34·1 | 1·41 | Grass, brown, leafy. |
| | | Oct., 1934 | ·07 | ·22 | ·06 | ·26 | trace | ·03 | 3·5 | 34·8 | 1·61 | Grass, brown, leafy. |
| | | Feb., 1935 | ·11 | ·39 | ·11 | ·76 | ·03 | ·18 | 5·6 | 33·3 | 2·49 | Grass, green, leafy. |
| | | April, 1935 | ·071 | ·34 | ·10 | ·45 | trace | ·26 | 3·6 | 31·7 | 1·88 | Grass, mainly green, leafy. |
| | | June, 1935 | ·067 | ·33 | ·09 | ·32 | trace | ·05 | 2·9 | 34·5 | 1·83 | Grass, brown, short. |
| | | Sept., 1935 | ·059 | ·21 | ·06 | ·18 | trace | ·04 | 3·5 | 34·0 | 1·32 | Grass, brown, short. |

## AREA 11 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Soetmelkfontein No. 322, P.O. Dennieton** | Pretoria....... | Dec., 1933 | ·23 | ·25 | ·16 | 2·66 | ·08 | ·70 | 12·6 | 32·9 | 5·33 | Grass, green. |
| | | April, 1934 | ·087 | ·32 | ·12 | 1·23 | ·02 | ·29 | 6·5 | 36·7 | 2·52 | Grass, mainly green. |
| | | April, 1935 | ·083 | ·55 | ·25 | 1·00 | ·03 | ·20 | 3·9 | 34·3 | 3·27 | Grass, mainly brown, short. |
| **Rietfontein No. 89 P.O. Bronkhorstspruit** | Pretoria....... | Mar., 1934 | ·08 | ·22 | ·15 | 1·37 | ·01 | ·15 | 4·2 | 36·6 | 2·58 | Grass, mainly green. |
| | | June, 1934 | ·028 | ·21 | ·11 | ·44 | trace | ·06 | 2·4 | 38·3 | 1·41 | Grass, mainly brown. |
| | | Sept., 1934 | ·051 | ·23 | ·11 | ·40 | ·02 | ·04 | 4·3 | 32·8 | 1·43 | Grass, mainly brown. |
| | | Feb., 1935 | ·090 | ·28 | ·12 | 1·93 | ·08 | ·27 | 6·3 | 36·2 | 3·44 | Grass, green, leafy. |
| **Kaalfontein No. 402, P.O. Rayton** | Pretoria....... | May, 1934 | ·055 | ·31 | ·20 | ·78 | ·02 | ·24 | 3·8 | 36·5 | 2·30 | Grass, mainly brown. |
| | | Sept., 1934 | ·042 | ·28 | ·08 | ·07 | trace | ·01 | 2·7 | 37·7 | 1·18 | Grass, brown. |
| | | Mar., 1935 | ·075 | ·30 | ·12 | ·77 | trace | ·06 | 4·6 | 34·7 | 2·00 | Grass, mainly green, leafy. |
| **Garsfontein......** | Pretoria....... | Feb., 1934 | ·10 | ·22 | ·18 | 1·66 | ·03 | ·37 | 6·5 | 37·0 | 3·24 | Grass, mainly green. |
| | | May, 1934 | ·043 | ·22 | ·19 | ·81 | ·02 | ·29 | 2·8 | 39·9 | 2·07 | Grass, mainly brown, long. |
| | | Aug., 1934 | ·049 | ·21 | ·17 | ·15 | trace | ·01 | 2·9 | 39·0 | 1·19 | Grass, brown. |
| | | Nov., 1934 | ·16 | ·28 | ·14 | 1·40 | trace | ·29 | 9·2 | 34·0 | 3·13 | Grass, green, long. |
| | | Mar., 1935 | ·11 | ·23 | ·13 | 1·35 | trace | ·21 | 3·5 | 40·3 | 2·46 | Grass, mainly green, long. |
| | | Aug., 1935 | ·039 | ·25 | ·10 | ·30 | trace | ·08 | 2·1 | 43·2 | 1·47 | Grass, brown, long. |
| **The Willows.....** | Pretoria....... | Mar., 1934 | ·11 | ·35 | ·49 | 1·52 | ·03 | ·31 | 10·0 | 34·8 | 4·10 | Grass, mainly green. |
| | | June, 1934 | ·036 | ·27 | ·43 | ·40 | ·02 | ·08 | 2·7 | 44·2 | 2·20 | Grass, mainly brown, long. |
| | | Sept., 1934 | ·038 | ·24 | ·17 | ·09 | ·02 | trace | 3·5 | 39·8 | 1·32 | Grass, brown, long. |
| | | April, 1935 | ·082 | ·29 | ·18 | ·66 | ·02 | ·09 | 4·1 | 36·7 | 1·97 | Grass, mainly green, long. |
| | | June, 1935 | ·053 | ·15 | ·19 | ·55 | trace | ·14 | 2·7 | 39·8 | 1·79 | Grass, brown, long. |
| **Rietfontein.......** | Pretoria....... | April, 1934 | ·076 | ·26 | ·16 | ·92 | ·03 | ·23 | 4·6 | 36·2 | 2·10 | Grass. |
| | | July, 1934 | ·035 | ·24 | ·35 | ·41 | trace | ·10 | 2·1 | 40·4 | 1·96 | Grass, mainly brown, long. |
| | | Oct., 1934 | ·055 | ·19 | ·21 | ·64 | ·02 | ·08 | 3·7 | 34·8 | 2·13 | Grass, mainly brown, leafy. |
| | | May, 1935 | ·077 | ·25 | ·15 | ·44 | trace | ·12 | 3·8 | 37·7 | 1·66 | Grass, mainly brown, leafy. |
| | | July, 1935 | ·052 | ·22 | ·14 | ·27 | trace | ·08 | 2·6 | 39·7 | 1·57 | Grass, brown, leafy. |
| **Kareefontein No. 838** | Waterberg..... | Nov., 1933 | ·23 | ·26 | ·22 | 3·39 | ·08 | ·52 | 15·6 | 30·7 | 6·68 | Grass, green. |
| | | April, 1935 | ·061 | — | — | ·78 | ·06 | ·31 | 3·6 | 34·7 | 1·82 | Grass, mainly green. |
| | | July, 1935 | ·055 | ·27 | ·13 | ·43 | ·02 | ·12 | 3·3 | 34·5 | 1·61 | Grass, brown, leafy. |
| **Hartebeestpoort No. 701, P.O. Vaalwater** | Waterberg..... | Dec., 1933 | ·22 | ·31 | ·19 | 2·48 | ·09 | ·33 | 10·1 | 33·0 | 5·24 | Grass, green. |
| | | May, 1935 | ·05 | ·23 | ·13 | ·48 | ·03 | ·09 | 3·8 | 33·1 | 1·68 | Grass, leafy. |
| | | Aug., 1935 | ·038 | ·21 | ·13 | ·40 | trace | ·13 | 3·0 | 40·2 | 1·44 | Grass, brown, short. |
| | | Nov., 1935 | ·14 | ·28 | ·32 | 2·51 | ·05 | ·61 | 15·1 | 30·7 | 5·08 | Grass, green, leafy. |

AREA II (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gemsbokfontein No. 383, P.O. Vaalwater | Waterberg..... | Mar., 1935 | ·063 | ·17 | ·13 | ·98 | ·05 | ·16 | 4·5 | 39·7 | 1·95 | Grass, mainly green, leafy. |
| | | June, 1935 | ·085 | ·24 | ·16 | ·42 | trace | ·13 | 2·8 | 40·0 | 1·45 | Grass, brown, leafy. |
| | | Sept., 1935 | ·050 | ·27 | ·13 | ·38 | ·03 | ·13 | 3·7 | 40·3 | 2·80 | Grass, brown, short. |
| Oranjefontein, P.O. Monte Christo | Waterberg..... | April, 1935 | ·10 | ·84 | ·33 | 2·36 | ·03 | ·33 | 9·4 | 34·8 | 6·07 | Grass, mainly green, and shrub. |
| | | July, 1935 | ·068 | 1·16 | ·64 | ·93 | ·01 | ·03 | 15·4 | 30·5 | 5·68 | Bush. |
| | | Oct., 1935 | ·053 | ·91 | ·58 | ·79 | ·02 | ·02 | 8·7 | 33·6 | 4·47 | Grass, brown, and bush. |
| | | Jan., 1936 | ·13 | ·67 | ·27 | 1·88 | trace | ·17 | 14·7 | 32·4 | 5·24 | Grass, leafy, and bush; mostly grass. |
| Penton Villa No. 1223, P.O. Ons Hoop, via Vaalwater | Waterberg..... | May, 1935 | ·07 | ·31 | ·23 | 1·13 | ·08 | ·21 | 7·0 | 34·6 | 2·89 | Grass and bush; mostly grass. |
| | | Aug., 1935 | ·09 | 1·12 | ·31 | 1·64 | trace | ·36 | 10·0 | 33·1 | 5·40 | Grass, brown, and bush. |
| | | Nov., 1935 | ·076 | 2·08 | 1·05 | ·95 | ·03 | ·04 | 11·8 | 26·9 | 7·98 | Bush. |
| | | Feb., 1936 | ·27 | ·93 | ·55 | 3·62 | ·16 | ·57 | 14·8 | 33·2 | 10·00 | Grass, green, and bush. |
| Dedam No. 444, P.O. Vaalwater | Waterberg..... | June, 1935 | ·20 | ·31 | ·21 | 1·44 | trace | ·25 | 16·3 | 28·4 | 5·60 | Grass, green, and bush; mostly bush. |
| | | Sept., 1935 | ·087 | ·97 | ·38 | 1·15 | ·04 | ·17 | 9·3 | 35·5 | 6·03 | Grass, brown, and bush; mostly bush. |
| | | Dec., 1935 | ·14 | 1·34 | ·37 | 1·76 | ·03 | ·09 | 10·5 | 28·5 | 7·75 | Bush. |
| | | Mar., 1936 | ·28 | ·94 | ·44 | 3·70 | ·05 | ·36 | 16·2 | 32·5 | 9·85 | Grass, green, and bush; mostly bush. |
| Scheerpoort No.60 | Brits.......... | Dec., 1933 | ·33 | ·37 | ·46 | 3·01 | ·41 | ·65 | 16·2 | 34·7 | 6·61 | Grass, green. |
| | | April, 1934 | ·088 | ·33 | ·13 | 1·95 | ·03 | ·24 | 6·0 | 36·6 | 3·52 | Grass, mainly green. |
| | | July, 1934 | ·070 | ·34 | ·13 | ·72 | trace | ·08 | 4·5 | 36·9 | 2·12 | Grass, brown. |
| | | Oct., 1934 | ·062 | ·35 | ·14 | ·49 | ·03 | ·08 | 4·4 | 39·6 | 1·66 | Grass, brown. |
| | | April, 1935 | ·099 | ·29 | ·17 | ·83 | trace | ·16 | 5·3 | 38·0 | 2·42 | Grass, mainly green. |
| Sandfontein No.54 | Brits.......... | Jan., 1934 | ·15 | ·31 | ·18 | 1·47 | ·02 | ·12 | 9·2 | 41·5 | 2·98 | Grass, mainly green. |
| | | May, 1934 | ·072 | ·42 | ·16 | 1·04 | ·01 | ·26 | 4·9 | 37·6 | 2·62 | Grass, mainly brown. |
| | | Aug., 1934 | ·025 | ·30 | ·18 | ·19 | trace | ·03 | 3·0 | 32·0 | 1·53 | Grass, brown. |
| | | Feb., 1935 | ·074 | ·25 | ·13 | ·70 | ·05 | ·11 | 5·6 | 36·4 | 1·98 | Grass, mainly green, leafy. |
| | | May, 1935 | ·076 | ·39 | ·14 | 1·48 | trace | ·24 | 4·7 | 34·7 | 3·01 | Grass. |
| | | Sept., 1935 | ·044 | ·26 | ·15 | ·39 | ·02 | ·11 | 3·6 | 38·2 | 1·91 | Grass, mainly brown. |
| De Kroon No. 33 | Brits.......... | Mar., 1934 | ·11 | ·35 | ·15 | 1·29 | trace | ·31 | 7·0 | 38·0 | 3·05 | Grass, mainly green. |
| | | June, 1934 | ·053 | ·47 | ·11 | ·38 | ·02 | ·11 | — | 36·2 | 2·41 | Grass, mainly brown. |
| | | Sept., 1934 | ·043 | ·61 | ·08 | ·28 | ·02 | ·04 | 3·8 | 36·2 | 1·86 | Grass, brown. |
| | | Mar., 1935 | ·062 | ·51 | ·06 | ·40 | trace | ·09 | 4·0 | 34·9 | 2·21 | Grass, mainly brown, leafy. |
| | | June, 1935 | ·057 | ·62 | ·12 | ·45 | trace | ·15 | 2·4 | 34·1 | 2·50 | Grass, brown, leafy. |
| | | Oct., 1935 | ·056 | ·86 | ·17 | ·34 | ·02 | ·05 | 4·6 | 36·6 | 3·47 | Grass, brown, leafy. |
| Witklip No. 704, P.O. Massikier | Brits.......... | Nov., 1933 | ·16 | ·49 | ·17 | 2·22 | ·08 | ·51 | 10·2 | 35·4 | 5·42 | Grass, short, and bush; mostly grass. |

## AREA 12.

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Senegal, P.O. Maribogo | Mafeking...... | Feb., 1935 | ·094 | ·29 | ·20 | 1·63 | trace | ·35 | 6·7 | 39·6 | 3·30 | Grass, mainly green, long. |
| | | May, 1935 | ·054 | ·37 | ·10 | ·77 | ·02 | ·08 | 6·0 | 35·6 | 2·16 | Grass and bush; mostly grass. |
| | | Aug., 1935 | ·068 | ·30 | ·13 | ·40 | ·01 | ·18 | 5·1 | 39·4 | 1·60 | Grass, brown. |
| | | Nov., 1935 | ·058 | ·38 | ·10 | ·51 | ·07 | ·03 | 7·0 | 35·8 | 2·20 | Grass. |
| Kildare, via Maribogo | Mafeking...... | Mar., 1935 | ·075 | ·29 | ·09 | ·50 | trace | ·07 | 5·2 | 38·1 | 1·66 | Grass. |
| | | June, 1935 | ·083 | ·22 | ·06 | ·32 | trace | ·03 | 3·8 | 43·2 | 1·13 | Grass, long. |
| | | Sept., 1935 | ·028 | ·46 | ·19 | ·43 | ·08 | ·02 | 4·8 | 38·0 | 2·30 | Grass, brown, long, and bush; mostly grass. |
| Burgundy, via Maribogo | Mafeking...... | April, 1935 | ·084 | ·73 | ·25 | 1·16 | ·09 | ·12 | 9·5 | 31·7 | 3·87 | Grass, mainly green, and bush; |
| | | July, 1935 | ·038 | ·16 | ·07 | ·23 | trace | ·06 | 3·3 | 42·0 | 1·00 | Grass, brown, long. |
| | | Oct., 1935 | ·045 | ·29 | ·13 | ·26 | trace | ·01 | 5·4 | 38·1 | 1·51 | Grass. |
| Kankatjies....... | Taungs........ | Nov., 1933 | ·12 | 1·07 | ·31 | 1·38 | ·03 | ·30 | 11·1 | 25·6 | 5·63 | Grass, brown, short and bush; mostly bush. |
| | | Feb., 1934 | ·19 | ·60 | ·32 | 2·20 | ·07 | ·41 | 10·2 | 31·6 | 6·78 | Grass, mainly green. |
| | | May, 1934 | ·076 | 1·09 | ·38 | 1·31 | trace | ·41 | 7·2 | 35·8 | 4·80 | Grass, mainly brown, short and bush; mostly grass. |
| | | Aug., 1934 | ·075 | ·98 | ·17 | ·99 | ·05 | ·31 | 6·9 | 32·5 | 4·39 | Grass, mainly brown, leafy and bush; mostly grass. |
| | | Feb., 1935 | ·20 | 1·34 | ·69 | 2·40 | ·14 | ·71 | 11·9 | 30·8 | 8·46 | Grass, green, leafy, and bush. |
| | | May, 1935 | ·17 | ·96 | ·47 | 2·01 | trace | ·50 | 9·8 | 32·3 | 6·08 | Grass and bush; mostly bush |
| Bowood......... | Taungs........ | Dec., 1933 | ·15 | ·79 | ·52 | 1·25 | ·03 | ·29 | 11·6 | 26·5 | 5·28 | Grass, mainly brown, and bush. |
| | | Mar., 1934 | ·13 | ·65 | ·38 | 1·74 | ·01 | ·33 | 7·3 | 34·2 | 4·57 | Grass, mainly green, and bush; mostly grass. |
| | | June, 1934 | ·059 | ·76 | ·32 | 1·00 | trace | ·26 | 7·2 | 33·7 | 3·47 | Grass, mainly brown, and bush; mostly grass. |
| | | Sept., 1934 | ·065 | ·86 | ·27 | 1·28 | ·02 | ·33 | 7·1 | 35·4 | 4·28 | Grass, leafy, and bush; mostly grass. |
| | | Mar., 1935 | ·096 | ·62 | ·25 | 1·32 | trace | ·24 | 7·5 | 34·6 | 3·61 | Grass, green. |
| | | June, 1935 | ·066 | ·72 | ·22 | ·83 | trace | ·14 | 4·8 | 33·8 | 3·11 | Grass, mainly brown, leafy and bush; mostly grass. |
| | | Sept., 1935 | ·066 | ·62 | ·17 | ·78 | ·03 | ·19 | 5·8 | 32·6 | 3·00 | Grass, brown, leafy. |
| Skietfontein...... | Taungs........ | Jan., 1934 | ·24 | 1·03 | ·50 | 2·01 | ·05 | ·40 | 14·6 | 27·2 | 7·32 | Grass, green, and bush. |
| | | April, 1934 | ·13 | ·87 | ·46 | 1·56 | trace | ·28 | 9·1 | 35·2 | 5·58 | Grass, mainly green, short, and bush; mostly grass. |
| | | July, 1934 | ·067 | ·93 | ·21 | ·87 | ·05 | ·15 | 5·7 | 33·7 | 3·96 | Grass, mainly brown, and bush. |
| | | Oct., 1934 | ·089 | 1·43 | ·40 | 1·13 | ·02 | ·18 | 8·0 | 28·8 | 5·22 | Grass, mainly brown, and bush; mostly bush. |
| | | April, 1935 | ·13 | 1·18 | ·37 | 1·30 | ·21 | ·19 | 9·1 | 31·8 | 5·40 | Grass and shrub. |
| | | July, 1935 | ·092 | 1·03 | ·33 | ·89 | ·19 | ·24 | 6·5 | 34·2 | 4·57 | Grass, mainly brown, leafy, and bush. |
| | | Oct., 1935 | ·065 | ·57 | ·22 | ·52 | ·02 | ·08 | 5·2 | 35·8 | 3·04 | Grass, mainly green. |

AREA 12 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Pro- tein. | Crude Fibre. | Solu- ble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Lewis**........... | Kuruman...... | Nov., 1933 | ·049 | ·14 | ·03 | ·15 | ·03 | ·02 | 3·1 | 35·1 | ·95 | Grass, brown. |
| | | Feb., 1934 | ·12 | ·28 | ·10 | 1·65 | ·03 | ·27 | 7·7 | 38·2 | 3·26 | Grass, green. |
| | | Aug., 1934 | ·028 | ·29 | ·07 | ·44 | trace | ·04 | 2·7 | 37·6 | 1·35 | Grass, brown, long. |
| | | Nov., 1934 | ·042 | ·17 | ·05 | ·33 | trace | ·04 | 3·5 | 39·2 | 1·04 | Grass, mainly brown, long. |
| | | May, 1935 | ·069 | ·29 | ·04 | ·31 | trace | ·05 | 3·6 | 40·8 | 1·29 | Grass, mainly brown, long. |
| | | Aug., 1935 | ·026 | ·18 | ·05 | ·22 | ·01 | ·07 | 3·7 | 39·3 | ·98 | Grass, mainly brown, long. |
| **Beaumont**....... | Kuruman...... | Dec., 1933 | ·043 | ·12 | ·02 | ·11 | trace | ·02 | 3·0 | 42·2 | ·78 | Grass, brown. |
| | | Mar., 1934 | ·098 | ·28 | ·11 | 1·45 | ·03 | ·34 | 7·8 | 37·6 | 2·73 | Grass, green. |
| | | June, 1934 | ·054 | ·27 | ·08 | ·49 | trace | ·09 | 2·7 | 39·7 | 1·57 | Grass, brown, long. |
| | | Sept., 1934 | ·038 | ·24 | ·04 | ·33 | trace | ·07 | 4·2 | 37·4 | 1·32 | Grass, brown, long. |
| | | Dec., 1934 | ·085 | ·22 | ·06 | ·75 | ·03 | ·10 | 4·4 | 40·8 | 1·62 | Grass, mainly green. long. |
| | | April, 1935 | ·074 | ·28 | ·06 | ·50 | trace | ·09 | 4·4 | 36·5 | 1·45 | Grass, mainly green. long. |
| | | July, 1935 | ·044 | ·18 | ·07 | ·29 | trace | ·07 | 4·1 | 41·8 | 1·06 | Grass, brown, long. |
| **Naylan**.......... | Kuruman...... | Jan., 1934 | ·067 | ·20 | ·07 | ·81 | ·01 | ·06 | 5·7 | 40·2 | 1·97 | Grass. |
| | | April, 1934 | ·14 | ·33 | ·13 | 1·65 | ·05 | ·36 | 5·2 | 38·5 | 3·44 | Grass. mainly green, long. |
| | | July, 1934 | ·11 | ·27 | ·06 | ·94 | ·02 | ·23 | 2·5 | 38·1 | 2·13 | Grass. brown, long. |
| | | Oct., 1934 | ·068 | ·23 | ·10 | ·88 | ·02 | ·09 | 3·3 | 39·2 | 1·94 | Grass, brown. long. |
| | | Jan., 1935 | ·11 | ·17 | ·07 | ·71 | ·02 | ·10 | 3·8 | 37·5 | 1·67 | Grass, mainly green, long. |
| | | Mar., 1935 | ·13 | ·27 | ·06 | ·77 | trace | ·11 | 3·7 | 38·0 | 1·91 | Grass, long. |
| | | June, 1935 | ·055 | ·21 | ·06 | ·39 | trace | ·11 | 3·8 | 40·2 | 1·22 | Grass, mainly brown, long. |
| | | Oct., 1935 | ·054 | ·26 | ·08 | ·39 | trace | ·05 | 4·2 | 38·4 | 1·44 | Grass, brown, long. |
| **De Rust (De Ben)** | Kuruamn...... | Nov., 1933 | ·13 | ·79 | ·34 | 1·00 | ·01 | ·13 | 10·5 | 32·7 | 5·50 | Bush. |
| | | Feb., 1934 | ·19 | 1·06 | ·23 | 2·19 | ·06 | ·40 | 13·2 | 30·4 | 8·16 | Bush. |
| | | May, 1934 | ·088 | 1·09 | ·34 | 1·75 | ·05 | ·25 | 11·0 | 33·5 | 6·08 | Grass, mainly green, and bush |
| | | Aug., 1934 | ·063 | ·60 | ·16 | ·67 | trace | ·07 | 5·7 | 38·1 | 2·63 | Grass, mainly brown, and bush |
| | | Oct., 1934 | ·16 | 1·03 | ·23 | 1·32 | ·03 | ·16 | 10·7 | 30·7 | 5·93 | Grass, mainly brown, and bush ; mostly bush. |
| | | Jan., 1935 | ·10 | ·99 | ·31 | 1·76 | ·04 | ·26 | 10·9 | 32·6 | 5·40 | Bush. |
| | | April, 1935 | ·19 | 1·60 | ·44 | 2·06 | ·42 | ·34 | 12·3 | 26·9 | 8·05 | Bush. |
| | | Aug., 1935 | ·037 | ·30 | ·08 | ·44 | ·01 | ·06 | 3·7 | 39·7 | 1·68 | Grass and bush ; mostly grass. |
| **Parys**........... | Kuruman...... | Jan., 1934 | ·35 | 1·22 | ·43 | 2·57 | ·05 | ·27 | 20·5 | 25·2 | 11·30 | Grass, green, and bush. |
| | | April, 1934 | ·16 | 1·56 | ·38 | 1·91 | ·03 | ·13 | 13·1 | 27·7 | 7·64 | Grass and bush ; mostly bush. |
| | | July, 1934 | ·045 | ·60 | ·10 | ·33 | ·01 | ·06 | 5·0 | 37·3 | 2·14 | Grass, mainly brown. |
| | | Nov., 1934 | ·056 | ·62 | ·16 | ·56 | trace | ·04 | 6·4 | 38·2 | 2·46 | Bush. |
| | | May, 1935 | ·087 | ·79 | ·15 | 1·10 | ·01 | ·15 | 7·5 | 38·6 | 3·76 | Grass, mainly green, and bush. |
| | | Sept., 1935 | ·077 | ·92 | ·35 | ·84 | ·13 | ·06 | 9·9 | 31·5 | 4·40 | Grass, brown, and bush ; mostly grass. |

## AREA 12 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Curtis........... | Kuruman...... | Mar., 1934 | ·18 | 1·42 | ·43 | 1·98 | ·03 | ·67 | 16·5 | 25·2 | 8·65 | Bush. |
| | | June, 1934 | ·087 | 1·47 | ·51 | 1·36 | ·04 | ·15 | 13·7 | 30·5 | 6·30 | Grass, mainly brown, and bush. |
| | | Sept., 1934 | ·051 | ·57 | ·13 | ·56 | ·01 | ·07 | 5·5 | 35·6 | 2·48 | Grass, brown, and bush. |
| | | Dec., 1934 | ·14 | ·96 | ·28 | 2·23 | ·08 | ·54 | 12·6 | 32·1 | 6·93 | Bush. |
| | | Mar., 1935 | ·083 | ·93 | ·24 | 1·18 | ·02 | ·19 | 8·3 | 37·5 | 4·50 | Grass, mainly green, and bush; mostly bush; |
| | | Oct., 1935 | ·066 | ·38 | ·07 | ·39 | ·02 | ·03 | 4·7 | 39·1 | 1·80 | Grass, brown. |
| Twyfel.......... | Kuruman...... | Jan., 1934 | ·03 | ·18 | ·06 | ·24 | ·01 | ·03 | 3·9 | 44·1 | 1·48 | Grass, brown. |
| | | April, 1934 | ·08 | ·34 | ·17 | 1·29 | ·04 | ·14 | 5·6 | 36·5 | 2·66 | Grass, mainly green, short. |
| | | Oct., 1934 | ·067 | ·34 | ·11 | ·51 | trace | ·09 | 4·7 | 40·9 | 1·97 | Grass. |
| | | Jan., 1935 | ·037 | ·17 | ·05 | ·45 | trace | ·09 | 3·8 | 37·1 | 1·32 | Grass, leafy. |
| | | April, 1935 | ·087 | ·29 | ·12 | ·86 | ·04 | ·13 | 4·7 | 37·0 | 2·14 | Grass, mainly green. |
| | | July, 1935 | ·053 | ·44 | ·12 | ·24 | trace | ·08 | 3·3 | 41·1 | 1·78 | Grass, mainly brown. |
| Rosendal........ | Kuruman...... | Feb., 1934 | ·087 | ·29 | ·12 | 1·05 | ·02 | ·08 | 7·2 | 39·6 | 2·65 | Grass, mainly green. |
| | | Aug., 1934 | ·047 | ·26 | ·10 | ·45 | trace | ·07 | 3·6 | 36·6 | 1·48 | Grass, mainly brown. |
| | | Oct., 1934 | ·056 | ·27 | ·10 | ·23 | trace | ·04 | 4·5 | 39·1 | 1·76 | Grass, mainly brown, short. |
| | | Feb., 1935 | ·13 | ·44 | ·30 | 1·32 | ·03 | ·20 | 8·5 | 38·0 | 3·53 | Grass, green. |
| | | June, 1935 | ·038 | ·21 | ·07 | ·26 | trace | ·05 | 2·9 | 42·3 | 1·12 | Grass, mainly brown. |
| | | Aug., 1935 | ·026 | ·30 | ·08 | ·17 | ·01 | ·07 | 3·0 | 38·5 | 1·31 | Grass, brown. |
| Mooihoek........ | Kuruman...... | Mar., 1934 | ·12 | ·41 | ·34 | 2·61 | ·04 | ·35 | 8·3 | 40·1 | 5·78 | Grass. |
| | | June, 1934 | ·065 | ·39 | ·15 | ·83 | ·06 | ·17 | 6·1 | 37·0 | 2·53 | Grass, mainly brown, and bush. |
| | | Sept., 1934 | ·076 | ·25 | ·14 | ·92 | ·02 | ·13 | 6·3 | 38·0 | 2·01 | Grass. |
| | | Mar., 1935 | ·10 | ·39 | ·12 | ·87 | ·06 | ·11 | 5·1 | 43·2 | 2·42 | Grass, green, long. |
| | | June, 1935 | ·043 | ·31 | ·08 | ·31 | trace | ·06 | 2·8 | 36·1 | 1·36 | Grass. |
| Vlakplaats....... | Vryburg....... | Mar., 1935 | ·07 | ·25 | ·09 | ·85 | ·02 | ·17 | 5·5 | 35·1 | 2·04 | Grass, green, long. |
| | | June, 1935 | ·04 | ·25 | ·09 | ·44 | trace | ·07 | 2·8 | 39·3 | 1·40 | Grass, brown, long. |
| | | Sept., 1935 | ·047 | ·25 | ·08 | ·36 | ·02 | ·09 | 3·6 | 39·8 | 1·51 | Grass, brown. |
| Uitval........... | Vryburg....... | May, 1935 | ·10 | ·46 | ·26 | 1·57 | ·03 | ·31 | 6·3 | 36·8 | 3·47 | Grass, mainly green, long. |
| | | Aug., 1935 | ·064 | ·36 | ·14 | ·77 | ·02 | ·14 | 4·6 | 38·7 | 2·27 | Grass, brown, long. |

AREA 12 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Woodhouse**...... | Vryburg....... | July, 1935 | ·053 | ·19 | ·10 | ·32 | trace | ·06 | 2·5 | 38·7 | 1·48 | Grass, brown, long. |
| | | Oct., 1935 | ·08 | ·26 | ·09 | ·36 | ·02 | ·02 | 3·3 | 34·8 | 1·71 | Grass, brown. |
| **Mistake**.......... | Vryburg....... | Dec., 1933 | ·18 | ·30 | ·23 | 1·11 | ·03 | ·33 | 14·1 | 30·9 | 4·92 | Grass, mainly green, and bush; mostly grass. |
| | | Mar., 1934 | ·14 | ·38 | ·17 | 1·66 | ·03 | ·37 | 7·9 | 35·0 | 3·55 | Grass, mainly green. |
| | | June, 1934 | ·047 | ·44 | ·09 | ·62 | — | ·10 | 5·0 | 35·4 | 2·23 | Grass, mainly brown, and bush; mostly grass. |
| | | Sept., 1934 | ·07 | ·51 | ·15 | 1·02 | trace | ·18 | 6·2 | 36·4 | 2·98 | Grass,, and bush; mostly grass. |
| | | Jan., 1935 | ·088 | ·39 | ·12 | 1·21 | ·03 | ·19 | 6·2 | 35·4 | 2·70 | Grass, mainly green, and bush: mostly grass. |
| | | April, 1935 | ·14 | ·40 | ·16 | 1·47 | ·06 | ·38 | 7·5 | 34·7 | 3·50 | Grass, green. |
| | | July, 1935 | ·073 | ·53 | ·12 | ·65 | ·01 | ·14 | 5·0 | 33·3 | 2·55 | Grass, brown, and bush; mostly grass. |
| **Belmont**......... | Vryburg....... | Jan., 1934 | ·14 | ·32 | ·16 | 2·06 | ·02 | ·42 | 9·0 | 38·0 | 4·31 | Grass, mainly green. |
| | | April, 1934 | ·11 | ·51 | ·17 | 1·54 | ·03 | ·34 | 10·0 | 33·3 | 4·19 | Grass, mainly green, and bush; mostly grass. |
| | | July, 1934 | ·063 | ·53 | ·18 | 1·01 | ·01 | ·23 | 6·5 | 33·7 | 3·17 | Grass, mainly brown, and bush. |
| | | Dec., 1934 | ·13 | ·33 | ·16 | 1·89 | ·04 | ·54 | 9·2 | 32·4 | 3·80 | Grass, green. |
| | | Feb., 1935 | ·12 | ·33 | ·11 | 1·18 | trace | ·25 | 6·6 | 36·1 | 2·66 | Grass, mainly green, and bush mostly grass. |
| | | June, 1935 | ·07 | ·57 | ·15 | ·83 | trace | ·15 | 6·9 | 36·0 | 2·65 | Grass, mainly brown, and bush. |
| | | Oct., 1935 | ·073 | ·46 | ·12 | ·72 | ·04 | ·11 | 5·1 | 36·8 | 2·53 | Grass, mainly brown. |
| **Renosterfontein**.. | Vryburg....... | Feb., 1934 | ·12 | ·35 | ·25 | 1·60 | ·02 | ·32 | 8·4 | 34·6 | 3·52 | Grass, green. |
| | | May, 1934 | ·057 | ·68 | ·15 | ·95 | trace | ·20 | 5·2 | 37·9 | 2·72 | Grass and bush; mostly grass. |
| | | Aug., 1934 | ·059 | ·56 | ·18 | ·72 | trace | ·11 | 5·7 | 35·7 | 2·65 | Grass, mainly brown, leafy, and bush; mostly grass. |
| | | Nov., 1934 | ·097 | ·39 | ·13 | 1·38 | trace | ·23 | 8·2 | 34·2 | 2·87 | Grass, green, leafy. |
| | | Mar., 1935 | ·073 | ·70 | ·12 | ·97 | trace | ·20 | 6·1 | 35·7 | 3·57 | Grass, mainly brown, and bush. |
| | | May, 1935 | ·074 | ·55 | ·18 | ·53 | ·02 | ·07 | 4·1 | 37·6 | 2·24 | Grass, mainly green, long. |
| | | Aug., 1935 | ·06 | ·73 | ·19 | ·85 | ·02 | ·15 | 5·5 | 34·8 | 3·45 | Grass, brown, and bush. |
| **Danielskuil**....... | Barkley West.. | Mar., 1934 | ·11 | ·31 | ·10 | ·95 | ·02 | ·17 | 6·3 | 38·6 | 2·34 | Grass, green. |
| | | Aug., 1934 | ·03 | ·44 | ·17 | ·67 | trace | ·15 | 3·1 | 38·8 | 2·07 | Grass, brown. |
| **Gordonshoop**..... | Barkley West.. | April, 1934 | ·11 | ·42 | ·24 | 1·39 | ·02 | ·19 | 8·4 | 34·9 | 4·17 | Grass, mainly green. |
| **Kramerfontein**.... | Barkley West.. | June, 1934 | ·08 | ·36 | ·11 | ·53 | ·01 | ·12 | 5·9 | 36·9 | 1·98 | Grass, mainly brown. |

## AREA 12 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Merton**.......... | Kimberley..... | Jan., 1934 | ·17 | ·43 | ·17 | 1·77 | ·04 | ·20 | 8·2 | 39·3 | 4·36 | Grass and bush; mostly grass. |
| | | April, 1934 | ·084 | ·82 | ·21 | 1·52 | ·04 | ·26 | 4·5 | 38·9 | 4·05 | Grass, short and bush. |
| | | July, 1934 | ·14 | ·76 | ·34 | 1·13 | ·01 | ·12 | 7·0 | 36·9 | 4·17 | Grass, brown, short and bush; mostly grass. |
| | | Oct., 1934 | ·08 | ·27 | ·06 | ·40 | ·03 | ·05 | 4·9 | 36·3 | 1·53 | Grass, brown. |
| | | Jan., 1935 | ·11 | ·34 | ·17 | 1·80 | ·04 | ·48 | 6·6 | 37·4 | 3·62 | Grass, green. |
| | | April, 1935 | ·16 | ·49 | ·22 | 1·39 | ·04 | — | 8·1 | 36·4 | 3·80 | Grass, green. |
| | | July, 1935 | ·23 | ·56 | ·26 | 1·85 | ·03 | — | 12·9 | 30·1 | 4·98 | Grass, brown, short and bush. |
| | | Oct., 1935 | ·17 | ·65 | ·21 | 1·28 | ·06 | ·31 | 9·3 | 36·8 | 3·92 | Grass, mainly green, short. |
| **Rooipan**......... | Kimberley..... | Feb., 1934 | ·22 | 1·23 | ·58 | 2·50 | ·03 | ·46 | 14·4 | 23·8 | 8·58 | Grass, green, short, and bush. |
| | | May, 1934 | ·10 | ·63 | ·29 | 1·02 | ·02 | ·27 | 6·9 | 38·7 | 3·46 | Grass, brown, short, and bush; mostly grass. |
| | | Aug., 1934 | — | 1·68 | — | 1·08 | trace | — | 9·2 | 34·2 | 6·46 | Bush. |
| | | Nov., 1934 | ·09 | ·54 | ·19 | 1·05 | ·02 | ·18 | 7·5 | 38·6 | 3·10 | Grass and bush; mostly grass. |
| | | Feb., 1935 | ·21 | ·47 | ·13 | 1·72 | trace | ·62 | 5·5 | 32·0 | 4·22 | Grass, short. |
| | | June, 1935 | ·14 | 1·54 | ·41 | 1·56 | ·09 | ·35 | 10·7 | 32·0 | 7·16 | Grass, mainly green, and bush; mostly bush. |
| | | Aug., 1935 | ·10 | ·84 | ·27 | ·93 | trace | ·15 | 7·2 | 41·0 | 4·73 | Grass, brown, short, and bush. |
| **Skietpanskop**..... | Kimberley..... | Mar., 1934 | ·25 | 1·95 | ·70 | 2·28 | ·02 | ·47 | 11·0 | 32·3 | 10·30 | Grass, green, short, and bush. |
| | | July, 1934 | ·14 | 2·35 | ·63 | 2·36 | ·03 | ·34 | 12·1 | 27·4 | 11·30 | Bush. |
| | | Sept., 1934 | ·075 | ·21 | ·08 | 1·24 | ·04 | ·30 | 6·4 | 38·4 | 3·07 | Grass, short. |
| | | Dec., 1934 | ·11 | 1·64 | ·76 | 2·73 | ·05 | — | — | — | 10·54 | Grass, green, short and bush; mostly bush. |
| | | Mar., 1935 | ·17 | ·34 | ·14 | 1·25 | ·07 | — | 8·9 | — | 4·33 | Grass, mainly green, short. |
| | | June, 1935 | ·14 | 1·50 | ·58 | 2·02 | ·36 | ·36 | 14·8 | 23·9 | 8·82 | Bush. |
| **Miskraal**......... | Kimberley..... | Mar., 1934 | ·15 | ·56 | ·31 | 1·60 | ·03 | ·33 | 8·0 | 35·6 | 4·60 | Grass, green, and bush; mostly grass. |
| | | Nov., 1934 | ·16 | ·91 | ·54 | 1·70 | ·17 | ·47 | 13·0 | 35·0 | 6·62 | Grass, mainly green, and bush. |
| | | July, 1935 | ·18 | 1·83 | ·68 | 2·15 | ·16 | ·40 | 12·6 | 31·8 | 9·82 | Bush. |
| | | Oct., 1935 | ·13 | ·75 | ·24 | 1·60 | ·02 | ·32 | 8·3 | 33·3 | 4·27 | Grass, mainly green, and bush. |

## AREA 13.

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Skietmekaar..... | Fauresmith.... | Feb., 1934 | ·17 | ·32 | ·20 | 2·76 | ·03 | ·53 | 12·2 | 32·0 | 5·40 | Grass, mainly green. |
| | | May, 1934 | ·17 | 1·38 | ·95 | 3·04 | ·24 | ·83 | 14·8 | 23·6 | 12·22 | Grass and bush; mostly bush. |
| | | Aug., 1934 | ·18 | ·94 | ·36 | ·66 | ·10 | ·46 | 7·3 | 29·7 | 5·17 | Grass, mainly brown, leafy, and bush; mostly grass. |
| | | Nov., 1934 | ·32 | 1·01 | ·40 | 2·28 | ·11 | ·96 | 16·5 | 24·3 | 7·40 | Grass, green, and bush; mostly bush. |
| | | Feb., 1935 | ·16 | ·65 | ·48 | 1·34 | ·10 | ·66 | 9·3 | 32·6 | 5·40 | Grass, mainly green, and bush; mostly grass. |
| | | May, 1935 | ·19 | ·98 | ·44 | 1·21 | ·13 | ·55 | 13·5 | 26·0 | 6·94 | Grass, green, and bush; mostly grass. |
| | | Aug., 1935 | ·16 | 1·21 | ·46 | 1·39 | ·33 | ·60 | 12·0 | 20·2 | 7·73 | Bush. |
| | | Nov., 1935 | ·15 | ·50 | ·23 | 1·09 | ·11 | ·44 | 8·8 | 30·5 | 3·84 | Grass, mainly green, and bush; mostly grass. |
| Bergplaas........ | Fauresmith.... | Mar., 1934 | ·18 | ·47 | ·45 | 2·39 | ·15 | ·75 | 11·1 | 32·0 | 6·14 | Grass, mainly green, and bush; mostly grass. |
| | | June, 1934 | ·16 | ·55 | ·15 | 1·10 | ·13 | ·87 | 6·6 | 31·2 | 4·23 | Grass, mainly brown, and bush, mostly grass. |
| | | Sept., 1934 | ·077 | ·35 | ·10 | ·53 | ·03 | ·22 | 4·6 | 37·6 | 1·78 | Grass, brown, and bush; mostly grass. |
| | | Dec., 1934 | ·20 | ·33 | — | 1·01 | ·07 | ·37 | 7·4 | 30·6 | 4·28 | Grass, mainly green, short. |
| | | Mar., 1935 | ·18 | ·53 | ·14 | 1·19 | ·03 | ·18 | 7·0 | 35·8 | 4·20 | Grass, mainly green, and bush; mostly grass. |
| | | June, 1935 | ·12 | ·79 | ·20 | ·62 | ·04 | ·21 | 7·5 | 30·3 | 4·25 | Grass and bush; mostly bush. |
| | | Sept., 1935 | ·13 | ·96 | ·34 | ·54 | ·03 | ·16 | 9·0 | 28·8 | 4·84 | Grass and bush; mostly grass. |
| Brandewyns Kuil. | Fauresmith.... | Jan., 1934 | ·30 | ·57 | ·45 | 3·15 | ·05 | ·50 | 18·0 | 26·0 | 7·70 | Grass, green and bush. |
| | | April, 1934 | ·23 | ·42 | ·27 | 1·58 | ·04 | ·15 | 8·6 | 32·8 | 4·22 | Grass, short. |
| | | July, 1934 | ·19 | 1·34 | ·59 | 1·88 | ·38 | ·63 | 9·8 | 25·1 | 8·38 | Grass, mainly brown, and bush; mostly bush. |
| | | Oct., 1934 | ·16 | 1·11 | ·28 | 1·63 | ·04 | ·64 | 9·1 | 26·7 | 7·52 | Grass, mainly green, and bush; mostly bush. |
| | | Jan., 1935 | ·30 | 1·79 | 1·05 | 3·56 | ·81 | ·63 | 19·1 | 25·6 | 15·42 | Grass, green, and bush; mostly bush. |
| | | April, 1935 | ·23 | ·82 | ·32 | 1·21 | trace | ·60 | 11·1 | 24·1 | 5·66 | Grass, mainly green, and bush; mostly grass. |
| | | July, 1935 | ·21 | 1·32 | ·49 | 1·75 | ·43 | ·43 | 10·2 | 25·1 | 8·11 | Grass and bush; mostly bush. |
| | | Oct., 1935 | ·18 | ·90 | ·36 | 1·65 | trace | ·36 | 12·2 | 25·1 | 5·58 | Grass, green, and bush; mostly grass. |
| Boesmansfontein. | Philippolis..... | Jan., 1934 | ·18 | ·56 | ·23 | 2·04 | ·05 | ·39 | 11·6 | 30·6 | 5·44 | Grass, green, and bush. |
| | | April, 1934 | ·21 | ·62 | ·25 | 1·56 | ·06 | ·32 | 8·6 | 29·5 | 4·42 | Grass, mainly green, and bush; mostly grass. |
| | | July, 1934 | ·14 | ·48 | ·15 | ·74 | ·02 | ·11 | 5·8 | 32·8 | 2·54 | Grass, mainly brown, and bush. |

## AREA 13 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Knapsak**......... | Philippolis..... | Feb., 1934 | ·15 | ·34 | ·19 | 1·80 | ·03 | ·34 | 8·2 | 35·8 | 4·60 | Grass, mainly green, and bush; mostly grass. |
| | | May, 1934 | ·16 | ·67 | ·31 | 1·41 | ·04 | ·23 | 6·4 | 33·5 | 4·35 | Grass, mainly brown, and bush. |
| | | Aug., 1934 | ·097 | ·73 | ·32 | 1·09 | ·06 | ·09 | 6·8 | 36·7 | 4·43 | Bush. |
| **Tuinplaats**....... | Philippolis..... | Mar., 1934 | ·26 | ·52 | ·32 | 2·04 | ·09 | ·36 | 9·4 | 32·6 | 5·52 | Grass, mainly green, and bush mostly grass. |
| | | June, 1934 | ·25 | ·47 | ·16 | 1·04 | ·04 | ·21 | 4·0 | 31·8 | 3·46 | Grass and bush; mostly grass. |
| **Koppieskraal**..... | Jacobsdal...... | Jan., 1934 | ·20 | ·47 | ·29 | 2·42 | ·04 | ·43 | 10·8 | 33·3 | 5·53 | Grass, mainly green, and bush; mostly grass. |
| | | April, 1934 | ·18 | ·42 | ·24 | 1·55 | ·01 | ·31 | 6·8 | 37·6 | 4·40 | Grass, mainly brown, and bush; mostly grass. |
| | | July, 1934 | ·15 | ·42 | ·20 | ·93 | ·02 | ·14 | 4·7 | 38·3 | 2·92 | Grass, brown, and bush; mostly grass. |
| | | Oct., 1934 | ·063 | ·26 | ·06 | ·21 | trace | ·02 | 2·6 | 28·1 | 1·23 | Grass, brown, and bush; mostly grass. |
| | | Jan., 1935 | ·10 | ·48 | ·22 | 1·16 | ·11 | ·36 | 5·9 | 36·9 | 3·38 | Grass, mainly brown, and bush. |
| | | April, 1935 | ·21 | 1·04 | ·51 | 3·12 | 1·05 | 1·03 | 11·8 | 27·5 | 10·00 | Grass, green, and bush; mostly bush. |
| | | July, 1935 | ·19 | ·91 | ·43 | 1·82 | 1·35 | ·81 | 10·4 | 33·2 | 7·87 | Grass and bush; mostly bush. |
| | | Oct., 1935 | ·13 | ·71 | ·40 | 1·55 | 1·10 | ·61 | 9·6 | 32·6 | 6·68 | Grass, mainly brown, and bush. |
| **Thomburg**....... | Jacobsdal...... | Feb., 1934 | ·15 | ·54 | ·21 | 1·63 | ·04 | ·28 | 7·9 | 37·0 | 4·21 | Grass and bush. |
| | | May, 1934 | ·083 | ·68 | ·24 | 1·39 | trace | ·24 | 8·3 | 35·5 | 3·95 | Grass, mainly brown, and bush. |
| | | Aug., 1934 | ·082 | ·41 | ·14 | ·93 | ·03 | ·20 | 5·2 | 40·4 | 2·59 | Grass, brown, and bush. |
| | | Nov., 1934 | ·13 | ·61 | ·29 | 2·00 | ·13 | ·33 | 10·7 | 32·1 | 5·08 | Grass, mainly green, and bush. |
| | | Feb., 1935 | ·18 | ·44 | ·27 | 1·52 | ·09 | ·37 | 10·1 | 33·0 | 4·48 | Grass and bush. |
| | | May, 1935 | ·27 | ·85 | ·56 | 2·94 | ·05 | ·42 | 11·1 | 30·8 | 7·66 | Grass, short, and bush; mostly bush. |
| | | Aug., 1935 | ·24 | ·79 | ·57 | 2·45 | ·29 | ·60 | 12·4 | 38·6 | 7·36 | Bush. |
| **Ramoth**......... | Jacobsdal...... | Mar., 1934 | ·18 | ·73 | ·43 | 2·19 | 1·54 | 1·35 | 11·2 | 30·1 | 9·28 | Grass and bush. |
| | | June, 1934 | ·12 | ·75 | ·33 | 1·00 | ·52 | ·25 | 6·4 | 36·8 | 4·54 | Grass, mainly brown, and bush. |
| | | Sept., 1934 | ·10 | ·61 | ·20 | ·71 | ·46 | ·18 | 4·5 | 36·4 | 3·47 | Grass, brown, and bush; mostly grass. |
| | | Dec., 1934 | ·16 | ·70 | ·31 | 2·23 | 1·15 | 1·04 | 10·4 | 30·1 | 8·61 | Grass, mainly green, and bush. |
| | | Mar., 1935 | ·14 | ·59 | ·28 | 1·27 | trace | ·17 | 6·2 | 34·9 | 3·85 | Grass, and bush. |
| | | June, 1935 | ·16 | ·98 | ·44 | 1·98 | trace | ·36 | 10·6 | 31·3 | 5·96 | Grass, mainly brown, and bush; mostly bush. |
| | | Sept., 1935 | ·14 | ·39 | ·17 | ·86 | ·02 | ·10 | 5·6 | 38·7 | 2·87 | Grass, brown, and bush; mostly grass. |
| **Bohhous**......... | Herbert........ | May, 1934 | ·16 | 1·63 | ·33 | 2·06 | ·08 | ·71 | 11·0 | 32·0 | 7·60 | Grass and bush; mostly grass. |
| | | April, 1935 | ·087 | ·86 | ·21 | 98 | ·13 | ·11 | 5·9 | 36·5 | 4·08 | Grass and bush. |
| | | May, 1935 | ·13 | ·84 | ·20 | 1·39 | trace | ·28 | 9·1 | 31·9 | 4·40 | Grass, mainly green, and bush. |
| | | Sept., 1935 | ·10 | ·62 | ·27 | ·92 | ·02 | ·20 | 7·8 | 35·0 | 3·15 | Grass, brown, and bush. |

### AREA 13 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vlakpan......... | Herbert........ | July, 1934 | ·17 | ·70 | ·30 | 1·47 | ·02 | ·40 | 7·8 | 33·0 | 4·27 | Grass, brown, and bush. |
| | | Oct., 1934 | ·096 | ·41 | ·16 | ·60 | ·01 | ·07 | 7·5 | 40·8 | 2·11 | Grass, brown, and bush; mostly grass. |
| | | Feb., 1935 | ·24 | ·71 | ·23 | 2·17 | trace | ·60 | 7·5 | 34·2 | 5·58 | Grass, mainly green, and bush. |
| | | Aug., 1935 | ·14 | ·95 | ·13 | 1·12 | trace | ·27 | 7·2 | 34·1 | 3·62 | Grass, mainly brown, and bush. |
| Olievenfontein.... | Trompsburg.... | Dec., 1933 | ·22 | ·47 | ·22 | 2·59 | ·07 | ·43 | 11·5 | 28·7 | 5·68 | Grass, green, short, and bush. |
| | | Mar., 1934 | ·14 | ·21 | ·08 | 1·16 | ·03 | ·25 | 5·0 | 36·6 | 2·57 | Grass. |
| | | June, 1934 | ·10 | ·19 | ·10 | ·73 | ·02 | ·18 | 2·5 | 37·6 | 1·89 | Grass, mainly brown. |
| | | Sept., 1934 | ·10 | ·35 | ·07 | ·36 | ·02 | ·03 | 2·7 | 37·4 | 1·62 | Grass, brown, and bush; mostly grass. |
| | | Dec., 1934 | ·17 | ·24 | ·09 | 1·21 | ·04 | ·19 | 6·1 | 38·5 | 2·58 | Grass, mainly green. |
| | | Mar., 1935 | ·14 | ·21 | ·07 | ·84 | ·01 | ·21 | 4·9 | 36·6 | 2·04 | Grass, mainly brown. |
| | | July, 1935 | ·15 | ·39 | ·15 | ·84 | ·03 | ·11 | 6·6 | 32·8 | 2·66 | Grass, brown, leafy, and bush. |
| | | Oct., 1935 | ·15 | ·26 | ·09 | ·74 | ·01 | ·09 | 6·3 | 32·8 | 2·15 | Grass, mainly brown, leafy. |
| Meyerskraal...... | Bethulie........ | Jan., 1934 | ·30 | ·41 | ·21 | 2·87 | ·04 | ·31 | 12·4 | 35·1 | 6·70 | Grass, mainly green, and bush; mostly grass. |
| | | April, 1934 | ·17 | ·23 | ·09 | ·94 | ·03 | ·13 | 4·4 | 38·6 | 2·32 | Grass, mainly brown. |
| | | July, 1934 | ·20 | ·43 | ·12 | ·49 | ·03 | ·04 | 3·5 | 35·5 | 2·27 | Grass, brown, and bush; mostly grass. |
| | | Oct., 1934 | ·16 | ·39 | ·16 | ·58 | ·02 | ·09 | 4·5 | 31·6 | 2·33 | Grass, brown, and bush; mostly grass. |
| | | Jan., 1935 | ·13 | ·21 | ·11 | ·76 | trace | ·14 | 4·8 | 42·2 | 1·90 | Grass, mainly green, long. |
| | | April, 1935 | ·16 | ·36 | ·12 | ·85 | ·10 | ·09 | 5·5 | 32·9 | 2·58 | Grass. |
| | | Aug., 1935 | ·12 | ·31 | ·10 | ·51 | ·03 | ·12 | 3·6 | 39·5 | 3·80 | Grass, brown, and bush; mostly grass. |
| Vaalbankfontein.. | Edenburg...... | Feb., 1934 | ·28 | ·32 | ·15 | 1·90 | ·04 | ·35 | 8·1 | 36·6 | 4·50 | Grass, mainly green. |
| | | Aug., 1934 | ·087 | ·26 | ·11 | ·38 | ·02 | ·02 | 2·1 | 36·8 | 1·59 | Grass, brown, long. |
| | | Nov., 1934 | ·12 | ·28 | ·07 | ·73 | trace | ·17 | 5·8 | 36·2 | 2·09 | Grass, mainly green, leafy. |
| | | Feb., 1935 | ·16 | ·33 | ·05 | ·91 | trace | ·05 | 3·6 | 36·2 | 2·20 | Grass, mainly brown, leafy. |
| | | May, 1935 | ·15 | ·30 | ·09 | ·70 | ·02 | ·09 | 4·5 | 39·2 | 2·16 | Grass, mainly brown. |
| | | Sept., 1935 | ·12 | ·35 | ·07 | ·58 | ·04 | ·05 | 4·9 | 34·3 | 3·84 | Grass, brown, leafy. |
| Daspoort........ | Dewetsdorp.... | Dec., 1933 | ·26 | ·31 | ·17 | 2·47 | ·06 | ·44 | 13·8 | 33·7 | 5·26 | Grass, mainly green. |
| | | Mar., 1934 | ·16 | ·20 | ·17 | 1·91 | ·04 | ·63 | 5·8 | 32·3 | 3·91 | Grass, mainly green, long. |
| | | June, 1934 | ·07 | ·22 | ·07 | ·25 | ·01 | ·05 | 2·2 | 38·7 | 1·18 | Grass, brown, long. |
| | | Oct., 1934 | ·067 | ·21 | ·06 | ·16 | trace | ·02 | 2·6 | 39·5 | 1·06 | Grass, brown, long. |
| | | Dec., 1934 | ·16 | ·20 | ·10 | 1·53 | ·04 | ·35 | 9·8 | 34·0 | 3·03 | Grass, green, long. |
| | | Mar., 1935 | ·095 | ·22 | ·10 | ·65 | trace | ·13 | 4·9 | 33·4 | 1·77 | Grass. |
| | | May, 1935 | ·10 | ·22 | ·07 | ·31 | trace | ·05 | 3·2 | 37·2 | 1·29 | Grass, mainly brown. |
| | | Sept., 1935 | ·074 | ·25 | ·08 | ·11 | ·03 | ·02 | 3·0 | 36·4 | 1·42 | Grass, brown, leafy. |

## AREA 14.

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Charnwood....... | Molteno....... | Dec., 1933 | ·19 | ·53 | ·25 | 1·96 | ·05 | ·41 | 11·3 | 32·7 | 5·20 | Grass, mainly green, and bush. |
| | | April, 1934 | ·20 | ·53 | ·25 | 1·54 | ·06 | ·31 | 8·6 | 32·0 | 4·23 | Grass, mainly green, and bush; mostly grass. |
| | | Aug., 1934 | ·15 | ·45 | ·20 | ·95 | ·05 | ·25 | 6·4 | 32·9 | 2·89 | Grass, mainly brown, and bush; mostly grass. |
| Dalkeith......... | Molteno....... | Jan., 1934 | ·20 | ·38 | ·20 | 2·26 | ·06 | ·38 | 8·8 | 36·6 | 5·04 | Grass, green, and bush. |
| | | Mar., 1934 | ·26 | ·58 | ·25 | 2·07 | ·05 | ·24 | 10·3 | 31·1 | 5·18 | Grass, mainly green, and bush; mostly grass. |
| | | June, 1934 | ·10 | ·31 | ·11 | ·60 | ·01 | ·17 | 2·7 | 37·3 | 2·19 | Grass, brown. |
| | | Sept., 1934 | ·10 | ·38 | ·16 | ·77 | ·11 | ·13 | 6·3 | 37·9 | 3·85 | Grass, mainly brown, and bush; mostly grass. |
| Van Zylsrust..... | Albert......... | Nov., 1933 | ·23 | ·79 | ·20 | 1·35 | ·04 | ·15 | 10·2 | 34·4 | 5·07 | Grass, green, short, and bush; mostly grass. |
| | | Feb., 1934 | ·22 | ·26 | ·16 | ·92 | ·04 | ·27 | 6·2 | 36·7 | 3·16 | Grass, mainly green. |
| | | May, 1934 | ·16 | ·45 | ·29 | 1·03 | ·04 | ·32 | 5·3 | 37·4 | 3·30 | Grass, mainly brown, and bush; mostly grass. |
| | | Aug., 1934 | ·14 | ·47 | ·20 | 1·30 | ·03 | ·22 | 7·5 | 35·0 | 3·46 | Grass and bush; mostly grass. |
| | | Nov., 1934 | ·12 | ·37 | ·14 | 1·01 | ·03 | ·15 | 6·2 | 36·1 | 2·71 | Grass, mainly green. |
| | | Feb., 1935 | ·24 | ·61 | ·25 | 1·57 | ·10 | ·64 | 11·9 | 31·7 | 4·57 | Grass, mainly green, and bush. |
| | | May, 1935 | ·17 | ·48 | ·17 | 1·00 | ·02 | ·15 | 7·5 | 30·2 | 3·65 | Grass, short, and bush. |
| | | Aug., 1935 | ·17 | ·47 | ·19 | 1·17 | trace | ·11 | 7·2 | 34·5 | 3·44 | Grass, mainly brown, short, and bush; mostly bush. |
| Hartbeestfontein. | Albert......... | Dec., 1933 | ·20 | ·40 | ·16 | 2·29 | ·07 | ·45 | 10·7 | 33·3 | 5·27 | Bush. |
| | | Mar., 1934 | ·25 | ·32 | ·25 | 1·56 | ·09 | ·35 | 6·5 | 35·9 | 4·14 | Grass, mainly green. |
| | | June, 1934 | ·16 | ·40 | ·15 | ·80 | ·03 | ·15 | 4·6 | 33·3 | 2·71 | Grass, mainly brown, short, and bush. |
| | | Sept., 1934 | ·10 | ·46 | ·17 | ·75 | ·13 | ·10 | 5·9 | 36·7 | 2·65 | Grass, brown, and bush. |
| | | Dec., 1934 | ·16 | ·52 | ·23 | 1·83 | ·23 | ·45 | 9·1 | 34·0 | 4·99 | Grass, mainly green, and bush. |
| | | Mar., 1935 | ·12 | ·37 | ·13 | ·96 | ·01 | ·10 | 5·9 | 38·7 | 2·57 | Grass and bush. |
| | | June, 1935 | ·17 | ·55 | ·19 | 1·32 | ·03 | ·20 | 8·4 | 31·8 | 3·79 | Grass, mainly brown, leafy, and bush. |
| | | Sept., 1935 | ·19 | ·71 | ·24 | 1·53 | ·03 | ·24 | 9·1 | 35·1 | 4·63 | Grass and bush; mostly bush. |
| Kapokkraal...... | Albert......... | Jan., 1934 | ·14 | ·24 | ·10 | 1·37 | ·04 | ·27 | 7·6 | 37·5 | 2·64 | Grass, mainly green. |
| | | April, 1934 | ·21 | ·39 | ·23 | 1·15 | ·04 | ·27 | 9·6 | 35·1 | 3·30 | Grass and bush; mostly grass. |
| | | July, 1934 | ·17 | ·57 | ·17 | ·96 | ·08 | ·27 | 6·7 | 31·8 | 3·00 | Grass, mainly brown, and bush; mostly grass. |
| | | Oct., 1934 | ·12 | ·26 | ·19 | ·90 | ·02 | ·17 | 7·4 | 27·4 | 2·86 | Grass and bush. |
| | | Jan., 1935 | ·19 | ·38 | ·22 | 1·70 | ·09 | ·56 | 6·5 | 36·0 | 4·16 | Grass and bush. |
| | | April, 1935 | ·13 | ·47 | ·14 | 1·13 | ·06 | ·13 | 6·2 | 36·2 | 3·26 | Grass, mainly green, short, and bush; mostly bush. |
| | | July, 1935 | ·11 | ·50 | ·13 | ·42 | ·01 | ·11 | 5·5 | 37·0 | 2·64 | Grass, mainly brown, short, and bush; mostly bush. |
| | | Oct., 1935 | ·16 | ·56 | ·19 | 1·47 | ·13 | ·28 | 6·4 | 33·9 | 4·22 | Grass, green, short ,and bush. |

AREA 14 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Zeekoegat-Boven.** | Venterstad..... | Dec., 1933 | ·25 | ·37 | ·24 | 1·78 | ·60 | ·82 | 11·9 | 31·0 | 5·19 | Grass, green, and bush; mostly grass. |
| | | Mar., 1934 | ·23 | ·29 | ·15 | 1·50 | ·08 | ·33 | 6·8 | 35·0 | 3·43 | Grass, green, and bush; mostly grass. |
| | | June, 1934 | ·20 | — | — | — | — | ·49 | 5·6 | 33·6 | — | Grass, mainly brown, and bush; mostly grass. |
| | | Sept., 1934 | ·18 | ·40 | ·15 | ·52 | ·07 | ·10 | 5·0 | 37·3 | 2·31 | Grass, brown, and bush; mostly grass. |
| | | Dec., 1934 | ·20 | ·43 | ·28 | 2·08 | ·14 | ·38 | 10·0 | 35·2 | 4·81 | Grass, green, and bush; mostly grass. |
| | | Mar., 1935 | ·11 | ·35 | ·12 | ·94 | ·04 | ·15 | 6·6 | 38·2 | 2·42 | Grass, mainly green, and bush; mostly grass. |
| | | June, 1935 | ·15 | ·41 | ·17 | ·95 | ·07 | ·17 | 6·9 | 34·3 | 3·07 | Grass, brown, and bush. |
| | | Sept., 1935 | ·17 | ·44 | ·10 | 1·57 | ·10 | ·25 | 8·2 | 33·2 | 3·85 | Grass, short, and bush; mostly grass. |
| **Kareefontein.....** | Venterstad..... | Jan., 1934 | ·31 | ·72 | ·31 | 2·88 | ·09 | ·37 | 17·7 | 29·4 | 7·08 | Grass, green, and bush. |
| | | April, 1934 | ·23 | ·47 | ·23 | 1·43 | ·04 | ·20 | 10·4 | 31·5 | 3·50 | Grass, mainly green, and bush; mostly grass. |
| | | July, 1934 | ·13 | ·40 | ·13 | ·52 | ·01 | ·04 | 9·8 | 37·1 | 2·18 | Grass, brown, and bush; mostly grass. |
| | | Oct., 1934 | ·17 | ·37 | ·14 | ·72 | ·02 | ·09 | 5·2 | 36·1 | 2·30 | Grass, brown, and bush; mostly grass. |
| | | Jan., 1935 | ·17 | ·29 | ·13 | 1·15 | ·02 | ·90 | 4·4 | 38·9 | 2·58 | Grass, long, and bush; mostly grass. |
| | | April, 1935 | ·18 | ·33 | ·13 | ·83 | ·03 | ·15 | 7·1 | 31·5 | 2·48 | Grass, mainly green, leafy. |
| | | July, 1935 | ·17 | ·53 | ·19 | 1·18 | ·02 | ·15 | 8·1 | 34·5 | 3·18 | Grass, brown, and bush. |
| | | Oct., 1935 | ·21 | ·72 | ·22 | 1·68 | ·04 | ·26 | 11·7 | 30·8 | 5·00 | Grass, mainly green, leafy, and bush. |
| **Twee Koppies....** | Venterstad..... | Feb., 1934 | ·15 | ·22 | ·09 | 1·40 | ·02 | ·23 | 8·1 | 37·0 | 2·89 | Grass, mainly green, and bush; mostly grass. |
| | | May, 1934 | ·11 | ·48 | ·18 | ·81 | ·01 | ·12 | 7·0 | 33·5 | 2·49 | Grass, mainly brown, and bush; mostly grass. |
| | | Aug., 1934 | ·15 | ·26 | ·15 | ·51 | ·01 | ·03 | 4·0 | 42·1 | 2·07 | Grass, brown, and bush; mostly grass. |
| | | Nov., 1934 | ·18 | ·36 | ·12 | 1·08 | ·04 | ·19 | 6·4 | — | 2·80 | Grass, mainly green, and bush; mostly grass. |
| | | Feb., 1935 | ·15 | ·36 | ·12 | ·84 | trace | ·89 | 5·2 | 37·7 | 2·27 | Grass, mainly brown, and bush; mostly grass. |
| | | May, 1935 | ·19 | ·33 | ·10 | ·62 | ·03 | ·08 | 5·1 | 39·7 | 2·23 | Grass, mainly brown, and bush; mostly grass. |
| | | Aug., 1935 | ·14 | ·41 | ·14 | ·62 | trace | ·11 | 5·6 | 34·6 | 2·33 | Grass, brown, leafy. |

AREA 14 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Broughton** ....... | Molteno ....... | Nov., 1933 | ·22 | ·35 | ·13 | 1·97 | ·06 | ·65 | 12·3 | 33·6 | 4·52 | Grass, mainly green. |
| | | Feb., 1934 | ·16 | ·25 | ·09 | 1·56 | ·03 | ·37 | 6·4 | 35·3 | 3·40 | Grass, mainly green. |
| | | May, 1934 | ·16 | ·42 | ·15 | 1·58 | ·09 | ·36 | 8·6 | 32·5 | 3·74 | Grass and bush; mostly grass. |
| | | July, 1934 | ·16 | ·40 | ·10 | ·91 | ·02 | ·21 | 7·1 | 32·3 | 2·65 | Grass and bush; mostly grass. |
| | | Oct., 1934 | ·17 | ·75 | ·16 | 1·34 | ·17 | ·32 | 8·3 | 31·7 | 4·37 | Grass. |
| **De Vlei** .......... | Murraysburg ... | Nov., 1934 | ·24 | ·68 | ·33 | 2·69 | ·37 | ·68 | 14·2 | 29·4 | 6·97 | Grass, mainly brown, and bush. |
| | | Feb., 1935 | ·17 | ·58 | ·15 | 1·08 | ·19 | ·11 | 7·1 | 35·3 | 4·00 | Bush. |
| | | Aug., 1935 | ·17 | ·70 | ·25 | 1·40 | ·56 | ·22 | 9·6 | 30·0 | 4·95 | Bush. |
| **Middelkop** ....... | Murraysburg ... | Dec., 1934 | ·14 | ·48 | ·20 | 1·42 | ·49 | ·29 | 8·3 | 37·8 | 4·62 | Grass, green, and bush; mostly bush. |
| | | Mar., 1935 | ·15 | 1·09 | ·24 | 1·28 | ·26 | ·07 | 8·5 | 40·4 | 6·02 | Bush. |
| | | Sept., 1935 | ·16 | ·74 | ·22 | 1·83 | ·49 | ·37 | 10·6 | 38·3 | 6·05 | Bush. |
| **Snyderskraal** ..... | Murraysburg ... | Jan., 1935 | ·15 | ·70 | ·20 | 1·44 | ·43 | ·47 | 6·5 | 41·9 | 5·60 | Bush. |
| | | April, 1935 | ·25 | ·96 | ·27 | 1·70 | ·65 | ·23 | 8·7 | 26·9 | 6·56 | Bush. |
| | | July, 1935 | ·16 | ·64 | ·21 | 1·18 | ·30 | ·21 | 7·4 | 36·9 | 4·59 | Grass, brown, and bush; mostly bush. |
| | | Oct., 1935 | ·21 | ·88 | ·44 | 2·14 | 1·45 | ·78 | 13·6 | 28·0 | 9·96 | Bush. |
| **Liebeeksfontein** ... | Richmond ..... | Dec., 1933 | ·14 | ·89 | ·25 | 1·23 | ·45 | ·29 | 9·9 | 33·7 | 5·71 | Bush. |
| | | Mar., 1934 | ·17 | ·67 | ·32 | 1·58 | ·09 | ·31 | 11·0 | 30·6 | 5·10 | Grass, green, short, and bush; mostly grass. |
| | | June, 1934 | ·11 | 1·00 | ·25 | 1·22 | ·21 | ·16 | 7·2 | 28·3 | 5·59 | Bush. |
| | | Sept., 1934 | ·14 | 1·10 | ·34 | 1·57 | ·09 | ·33 | 7·5 | 37·7 | 6·67 | Bush. |
| | | Dec., 1934 | ·14 | ·39 | ·12 | 1·27 | ·17 | ·23 | 5·7 | 36·6 | 3·20 | Grass, green. |
| | | Mar., 1935 | ·15 | ·47 | ·11 | 1·48 | ·03 | ·09 | 6·0 | 43·6 | 3·67 | Bush. |
| | | June, 1935 | ·13 | ·79 | ·26 | 1·43 | ·03 | ·15 | 8·9 | 33·1 | 5·25 | Bush. |
| | | Sept., 1935 | ·16 | ·71 | ·29 | 1·71 | ·07 | ·17 | 9·0 | 33·9 | 5·10 | Bush. |
| **Palmietfontein** ... | Richmond ..... | Jan., 1934 | ·23 | ·26 | ·11 | ·84 | ·06 | ·33 | 11·9 | 34·1 | 5·90 | Grass, green, and bush. |
| | | April, 1934 | ·23 | ·59 | ·38 | 3·16 | ·07 | ·51 | 11·4 | 27·6 | 6·95 | Grass, mainly green, short, and bush. |
| | | Oct., 1934 | ·14 | ·47 | ·16 | 1·54 | ·04 | ·16 | 6·1 | 44·1 | — | Bush. |
| | | Jan., 1935 | ·14 | ·42 | ·13 | 1·21 | ·10 | ·11 | 7·4 | 44·2 | 3·62 | Bush. |
| | | May, 1935 | ·17 | ·53 | ·17 | 1·77 | ·05 | ·18 | 8·1 | 38·1 | 4·60 | Bush. |
| | | Aug., 1935 | ·16 | ·73 | ·22 | 1·59 | ·05 | ·23 | 8·5 | 34·7 | 5·06 | Bush. |

AREA 14 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Grootfontein**..... | Richmond..... | Feb., 1934 | ·16 | ·44 | ·23 | 1·92 | ·07 | ·25 | 7·1 | 33·7 | 4·34 | Grass, mainly green, and bush; mostly grass. |
| | | May, 1934 | ·08 | ·75 | ·26 | 1·26 | ·08 | ·12 | 5·7 | 39·6 | 4·63 | Bush. |
| | | Nov., 1934 | ·14 | 1·04 | ·45 | 1·93 | ·12 | ·39 | 10·0 | 31·7 | 6·56 | Grass, short, and bush. |
| | | April, 1935 | ·15 | ·86 | ·24 | 1·93 | ·16 | ·18 | 8·1 | 29·7 | 5·38 | Bush. |
| | | July, 1935 | ·23 | ·58 | ·29 | 1·32 | ·80 | ·32 | 9·1 | 39·5 | 5·72 | Bush. |
| | | Oct., 1935 | ·26 | 1·65 | ·99 | 2·91 | ·06 | ·59 | 10·8 | 30·9 | 10·63 | Bush. |
| **Onbekend**........ | Middelburg.... | April, 1934 | ·27 | 1·13 | ·30 | 2·80 | ·03 | ·60 | 13·2 | 30·6 | 7·45 | Grass, mainly green, leafy, and bush; mostly grass. |
| | | June, 1934 | ·19 | 1·19 | ·48 | 2·09 | ·15 | ·37 | 12·0 | 28·3 | 7·44 | Bush. |
| | | Mar., 1935 | ·12 | ·90 | ·56 | 2·73 | 1·12 | ·40 | 9·8 | 34·5 | 9·20 | Bush. |
| | | Sept., 1935 | ·25 | ·73 | ·36 | 2·63 | ·37 | ·88 | 15·2 | 25·8 | 7·34 | Grass, green, leafy. |
| **Lansdowne**....... | Middelburg..... | Jan., 1934 | ·26 | ·39 | ·19 | 2·00 | ·04 | ·33 | 9·5 | 33·2 | 4·67 | Grass, mainly green. |
| | | April, 1934 | ·21 | ·82 | ·26 | 2·26 | ·07 | ·32 | 8·7 | 33·6 | 6·16 | Grass, mainly green, and bush; mostly bush. |
| | | July, 1934 | ·12 | ·43 | ·13 | 1·21 | ·12 | ·15 | 6 5 | 43·9 | 3·69 | Bush. |
| | | April, 1935 | ·23 | 1·47 | ·38 | 2·54 | ·43 | ·34 | 11·8 | 30·9 | 8·36 | Bush. |
| | | Oct., 1935 | ·16 | ·49 | ·29 | 1·45 | ·11 | ·30 | 7·3 | 38·6 | 3·81 | Grass, mainly brown, and bush; mostly bush. |
| **Hillmoor**......... | Steynsburg..... | Dec., 1933 | ·26 | ·29 | ·10 | 2·85 | ·05 | ·28 | 12·3 | 28·1 | — | Grass, mainly green, short. |
| | | Mar., 1934 | ·13 | ·31 | ·15 | 1·33 | ·02 | ·23 | 6·8 | 35·5 | 2·68 | Grass, mainly green. |
| | | June, 1934 | ·16 | ·54 | ·20 | ·98 | ·03 | ·17 | 7·6 | 31·7 | 3·92 | Grass, mainly green, and bush. |
| | | Sept., 1934 | ·11 | ·36 | ·13 | 1·08 | ·03 | ·08 | 5·5 | 35·5 | 2·06 | Grass, mainly brown, short, and bush; mostly grass. |
| | | Feb., 1935 | ·15 | ·28 | ·07 | 1·15 | trace | ·21 | 5·7 | 27·7 | 2·71 | Grass, mainly green, short. |
| | | May, 1935 | ·21 | ·39 | ·17 | 1·41 | trace | ·16 | 8·0 | 33·2 | 3·52 | Grass, mainly green, short, and bush; mostly bush. |
| | | Aug., 1935 | ·18 | ·56 | ·16 | 1·40 | ·03 | ·16 | 9·2 | 32·1 | 3·97 | Grass, mainly brown, short, and bush. |
| **Grootvlei**........ | Steynsburg..... | Jan., 1934 | ·27 | ·48 | ·29 | 2·62 | ·07 | ·39 | 12·1 | 34·4 | 6·60 | Grass, brown, and bush; mostly bush. |
| | | April, 1934 | ·31 | ·78 | ·74 | 2·89 | ·28 | ·95 | 11·8 | 28·4 | 8·32 | Grass, leafy, and bush. |
| | | July, 1934 | ·20 | 1·33 | ·67 | 2·25 | ·03 | 1·02 | 17·3 | 24·6 | 8·15 | Bush. |
| | | Oct., 1934 | ·16 | 1·07 | ·47 | 2·09 | 1·01 | ·41 | 12·7 | 30·8 | 9·00 | Bush. |
| | | Mar., 1935 | ·23 | 1·48 | ·92 | 2·87 | ·63 | ·33 | 9·6 | 32·7 | 10·55 | Bush. |
| | | June, 1935 | ·18 | ·96 | ·43 | 1·59 | ·04 | ·40 | 9·9 | 29·4 | 5·68 | Bush. |
| | | Sept., 1935 | ·22 | ·98 | ·49 | 2·70 | ·07 | ·46 | 10·4 | 24·5 | 7·91 | Bush. |

AREA 14 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jakhalsfontein.... | Colesberg...... | Feb., 1934 | ·21 | ·33 | ·22 | 2·41 | ·36 | ·54 | 11·3 | 31·9 | 6·01 | Grass, mainly green, and bush. |
| | | May, 1934 | ·36 | ·77 | ·35 | 3·17 | ·10 | 1·08 | 11·5 | 30·4 | 8·02 | Grass, mainly green, short, and bush. |
| | | Aug., 1934 | ·20 | ·47 | — | 1·84 | ·02 | ·24 | 7·1 | 39·0 | 4·83 | Grass, short, and bush; mostly bush. |
| | | Nov., 1934 | ·26 | ·70 | ·26 | 2·52 | ·04 | ·50 | 13·9 | 31·8 | 6·54 | Bush. |
| | | April, 1935 | ·22 | ·58 | ·21 | 1·74 | ·08 | ·13 | 8·8 | 30·6 | 4·44 | Bush. |
| | | July, 1935 | ·15 | ·71 | ·24 | 1·40 | trace | ·20 | 9·2 | 33·4 | 4·47 | Bush. |
| | | Oct., 1935 | ·18 | ·46 | ·30 | 1·59 | ·25 | ·26 | 9·0 | 34·7 | 4·30 | Grass and bush; mostly grass. |
| Slingersfontein.... | Philipstown.... | Jan., 1934 | ·44 | ·52 | ·30 | 2·55 | ·95 | 1·05 | 12·9 | 31·3 | 8·66 | Grass, mainly green, and bush; mostly grass. |
| | | April, 1934 | ·16 | 1·04 | ·52 | 1·69 | ·58 | ·40 | 9·3 | 24·4 | 6·44 | Grass, mainly brown, short, and bush; mostly grass. |
| | | July, 1934 | ·19 | 1·20 | ·36 | 1·91 | ·26 | ·28 | 8·8 | 35·0 | 7·19 | Bush. |
| | | Oct., 1934 | ·17 | ·79 | ·53 | 1·61 | ·41 | ·28 | 8·6 | 26·2 | 6·24 | Bush. |
| | | Jan., 1935 | ·12 | ·56 | ·30 | 1·81 | ·04 | ·23 | 6·9 | 41·0 | 4·43 | Grass, mainly green, short, and bush; mostly bush. |
| | | April, 1935 | ·24 | ·82 | ·39 | 1·70 | ·37 | ·54 | 10·3 | — | 6·88 | Bush. |
| | | July, 1935 | ·17 | ·82 | ·40 | 1·44 | ·24 | ·20 | 8·5 | 40·3 | 5·34 | Bush. |
| | | Oct., 1935 | ·21 | ·55 | ·24 | 1·63 | ·17 | ·24 | 8·5 | 32·0 | 4·21 | Grass, green, short, and bush. |
| Carmilrust....... | Philipstown.... | Feb., 1934 | ·24 | ·90 | ·59 | 2·69 | ·54 | ·43 | 14·2 | 27·6 | 9·00 | Grass, mainly green, and bush. |
| | | May, 1934 | ·15 | 1·00 | ·35 | 2·36 | ·02 | ·26 | 9·8 | 28·8 | 7·14 | Grass, mainly brown, and bush. |
| | | Aug., 1934 | ·16 | ·56 | ·38 | 1·59 | 2·74 | 1·87 | 8·1 | 32·3 | 10·96 | Grass, brown, and bush; mostly bush. |
| | | Nov., 1934 | ·14 | ·53 | ·29 | 1·98 | 1·05 | ·41 | 9·8 | 33·7 | 7·36 | Bush. |
| | | Feb., 1935 | ·15 | ·79 | ·38 | 2·23 | ·23 | ·32 | 9·3 | 35·7 | 6·61 | Bush. |
| | | May, 1935 | ·20 | 1·04 | ·58 | 2·84 | ·41 | ·54 | 12·4 | 31·9 | 8·96 | Bush. |
| | | Aug., 1935 | ·20 | ·84 | ·50 | 2·65 | 2·13 | 1·49 | 12·0 | 28·9 | 12·20 | Bush. |
| Oosthuisfontein... | Philipstown.... | Mar., 1934 | ·30 | ·79 | ·31 | 2·46 | ·07 | ·36 | 15·4 | 25·5 | 7·42 | Grass, green, short, and bush. |
| | | June, 1934 | ·15 | ·78 | ·21 | 1·47 | ·04 | ·21 | 9·7 | 34·7 | 4·56 | Bush. |
| | | Sept., 1934 | ·10 | ·70 | ·23 | 1·65 | ·03 | ·12 | 6·3 | 44·3 | 3·95 | Bush. |
| | | Mar., 1935 | ·16 | ·81 | ·24 | 1·52 | ·07 | ·09 | 7·7 | 37·9 | 5·32 | Bush. |
| | | June, 1935 | ·16 | ·92 | ·42 | 2·13 | ·04 | ·29 | 10·4 | 28·7 | 6·74 | Bush. |
| | | Sept., 1935 | ·15 | ·97 | ·35 | 1·26 | ·05 | ·12 | 8·0 | 34·3 | 5·68 | Bush. |

AREA 14 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **De Poort**........ | De Aar........ | Feb., 1934 | ·25 | ·59 | ·35 | 3·32 | ·52 | ·66 | 12·6 | 29·0 | 8·38 | Grass, green, and bush; mostly grass. |
| | | May, 1934 | ·11 | ·97 | ·21 | 1·21 | ·71 | ·43 | 7·2 | 37·2 | 4·28 | Grass, mainly brown, and bush; mostly grass. |
| | | Nov., 1934 | ·15 | ·67 | ·23 | 1·76 | ·26 | ·37 | 9·5 | 37·3 | 4·78 | Grass, mainly brown, and bush; mostly bush. |
| | | April, 1935 | ·17 | 1·37 | ·46 | 2·74 | ·26 | ·38 | 11·3 | 30·2 | 8·88 | Bush. |
| | | July, 1935 | ·16 | 1·20 | ·40 | 1·79 | ·15 | ·35 | 10·6 | 34·2 | 6·97 | Bush. |
| | | Oct., 1935 | ·15 | ·87 | ·34 | 1·53 | ·19 | ·23 | 7·2 | 35·4 | 5·48 | Bush. |
| **Merino**.......... | De Aar........ | Mar., 1934 | ·21 | ·85 | ·47 | 1·61 | ·15 | ·39 | 9·5 | 30·3 | 5·90 | Grass, mainly green, and bush; mostly grass. |
| | | June, 1934 | ·13 | ·80 | ·30 | 1·60 | ·49 | ·36 | 8·2 | 33·7 | 6·24 | Grass, brown, and bush; mostly bush. |
| | | Nov., 1934 | ·12 | ·61 | ·24 | 1·69 | ·40 | ·44 | 6·2 | 42·9 | 4·95 | Bush. |
| | | May, 1935 | ·15 | 1·28 | ·52 | 2·58 | ·27 | ·32 | 10·7 | 36·6 | 8·12 | Bush. |
| | | Aug., 1935 | ·18 | ·76 | ·34 | 1·33 | ·15 | ·30 | 8·5 | 34·3 | 5·20 | Bush. |
| **Badenhorstdam**... | De Aar........ | April, 1934 | ·11 | ·77 | ·23 | 1·15 | ·01 | ·16 | 5·2 | 34·5 | 4·30 | Grass, mainly brown, and bush; mostly grass. |
| | | Sept., 1934 | ·09 | ·57 | ·23 | ·54 | ·05 | ·08 | 7·5 | 37·3 | 2·80 | Grass, brown, and bush; mostly grass. |
| | | Mar., 1935 | ·15 | ·76 | ·35 | 1·92 | ·07 | ·24 | 11·6 | 33·2 | 5·48 | Grass, mainly green, and bush. |
| | | June, 1935 | ·13 | 1·08 | ·42 | 2·08 | ·04 | ·20 | 10·6 | 34·3 | 6·66 | Bush. |
| | | Sept., 1935 | ·13 | 1·52 | ·69 | 2·30 | ·06 | ·15 | 12·8 | 31·5 | 8·60 | Bush. |

## AREA 15

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Theescombe...... | Port Elizabeth. | Nov., 1933 | ·10 | ·41 | ·20 | ·82 | ·51 | ·46 | 6·9 | 30·4 | 3·93 | Grass, mainly green, and bush. |
| | | Feb., 1934 | ·04 | ·33 | ·14 | ·53 | ·29 | ·36 | 4·0 | 31·8 | 2·34 | Grass, mainly brown, and bush; mostly grass. |
| | | May, 1934 | ·033 | ·39 | ·17 | ·37 | ·34 | ·33 | 4·0 | 32·2 | 2·46 | Grass and bush. |
| | | Aug., 1934 | ·13 | ·63 | — | ·78 | ·43 | ·87 | 8·2 | 33·3 | 3·84 | Grass, and bush; mostly grass. |
| | | April, 1935 | ·09 | ·93 | ·19 | ·71 | ·44 | ·76 | 6·8 | 33·9 | 4·74 | Grass, mainly green, and bush. |
| | | June, 1935 | ·13 | ·68 | ·23 | 1·39 | ·15 | ·77 | 13·5 | 32·6 | 4·74 | Grass, mainly green, and bush. |
| | | Sept., 1935 | ·056 | ·70 | ·23 | ·47 | ·26 | ·38 | 6·1 | 33·8 | 3·71 | Grass, mainly brown, and bush. |
| Yellowoods....... | Port Elizabeth. | Jan., 1934 | ·08 | ·60 | ·14 | 1·17 | ·20 | ·56 | 6·7 | 33·9 | 4·82 | Grass and bush. |
| | | April, 1934 | ·14 | ·63 | ·26 | 1·07 | ·48 | ·82 | 8·7 | 34·6 | 5·00 | Grass and bush; mostly grass. |
| | | Feb., 1935 | ·07 | 1·54 | ·14 | ·88 | ·24 | ·49 | 6·5 | 33·9 | 5·68 | Grass, mainly green, short, and bush. |
| | | June, 1935 | ·07 | 1·25 | ·16 | ·81 | ·43 | ·44 | 6·1 | 32·0 | 5·08 | Grass, mainly green, and bush; mostly bush. |
| | | Aug., 1935 | ·13 | 1·15 | ·17 | ·85 | ·29 | ·32 | 9·1 | 29·4 | 4·66 | Grass, mainly green, leafy, and bush. |
| Glen Connor..... | Uitenhage...... | Nov., 1933 | ·20 | ·79 | ·29 | 2·07 | 1·77 | 1·77 | 12·7 | 29·9 | 10·60 | Grass, green, and bush; mostly bush. |
| | | Mar., 1934 | ·15 | ·50 | ·34 | 1·75 | ·41 | ·66 | 11·0 | 31·1 | 5·62 | Grass, mainly green, and bush; mostly grass. |
| | | May, 1934 | ·14 | 1·20 | ·36 | 1·81 | ·91 | ·93 | 11·4 | 29·3 | 9·12 | Bush. |
| | | Sept., 1934 | ·22 | ·38 | ·12 | ·35 | 1·55 | 1·11 | 14·4 | 23·9 | — | Bush. |
| | | Mar., 1935 | ·21 | 1·31 | ·53 | 2·21 | ·91 | ·34 | 9·8 | 27·8 | 10·10 | Bush. |
| | | June, 1935 | ·16 | 1·05 | ·76 | 1·33 | ·62 | ·39 | 14·3 | 28·3 | 7·04 | Bush. |
| | | Sept., 1935 | ·12 | ·90 | ·36 | 1·60 | ·29 | ·43 | 7·6 | 27·7 | 6·30 | Bush. |
| Wolwefontein.... | Uitenhage...... | Dec., 1933 | ·13 | 1·10 | ·28 | 1·47 | ·33 | ·55 | 10·6 | 24·3 | 6·76 | Bush. |
| | | June, 1934 | ·13 | ·68 | ·16 | 1·17 | ·50 | ·27 | 8·1 | 39·6 | 5·03 | Bush. |
| | | Nov., 1934 | ·22 | ·75 | ·19 | 1·96 | ·39 | ·43 | 10·2 | 31·2 | 5·67 | Grass, green, and bush; mostly bush. |
| | | April, 1935 | ·13 | ·88 | ·39 | 1·69 | ·42 | ·57 | 8·0 | 32·4 | 5·97 | Bush. |
| | | July, 1935 | ·23 | ·90 | ·73 | 2·70 | 2·89 | 1·84 | 16·7 | 21·0 | 16·30 | Bush. |
| | | Oct., 1935 | ·11 | ·87 | ·42 | 1·60 | ·51 | ·56 | 7·5 | 31·2 | 5·84 | Grass, mainly green, and bush; mostly grass. |
| Brakhill......... | Uitenhage...... | Jan., 1934 | ·13 | 1·09 | ·84 | 2·23 | 1·46 | 1·79 | 13·7 | 24·5 | 11·75 | Bush. |
| | | April, 1934 | ·22 | 1·15 | ·60 | 2·34 | 2·09 | 2·62 | 14·8 | 22·1 | 13·25 | Bush. |
| | | July, 1934 | ·12 | 1·48 | ·34 | 1·89 | ·25 | ·49 | 10·7 | 27·0 | 7·50 | Bush. |
| | | Sept., 1934 | ·13 | 1·14 | ·58 | 1·33 | ·47 | ·46 | 15·9 | 23·5 | 9·70 | Bush. |
| | | Dec., 1934 | ·17 | 1·13 | ·56 | 2·48 | 2·29 | 2·87 | 14·4 | 24·6 | 14·25 | Bush. |
| | | May, 1935 | ·13 | 1·05 | ·51 | 1·45 | ·50 | ·39 | 10·1 | 27·1 | 7·24 | Bush. |
| | | Aug., 1935 | ·16 | ·86 | ·47 | 1·69 | ·58 | ·46 | 10·0 | 32·0 | 9·66 | Bush. |

AREA 15 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Centerlivers...... | Uitenhage...... | Mar., 1934 | ·20 | 1·36 | ·52 | 2·54 | 1·57 | 2·29 | 12·8 | 23·3 | 12·85 | Bush. |
| | | June, 1934 | ·10 | 1·36 | ·43 | 1·36 | ·33 | ·64 | 9·7 | 22·2 | 7·26 | Bush. |
| | | Sept., 1934 | ·18 | 1·80 | ·40 | 1·76 | ·65 | ·93 | 13·4 | 23·9 | 9·00 | Bush. |
| | | Mar., 1935 | — | ·90 | ·39 | 1·60 | ·57 | — | 5·6 | 36·0 | 6·86 | Grass, mainly brown, and bush; mostly bush. |
| | | July, 1935 | ·32 | ·67 | ·22 | 2·83 | ·54 | 1·06 | 19·8 | 28·1 | 7·80 | Grass, green, short. |
| | | Oct., 1935 | ·23 | ·85 | ·19 | 1·65 | ·39 | ·79 | 7·8 | 32·7 | 5·96 | Bush. |
| Brakrivier....... | Jansenville..... | Nov., 1934 | ·11 | 1·68 | ·36 | ·84 | ·58 | ·25 | 4·5 | 39·1 | 7·64 | Bush. |
| | | Feb., 1935 | ·11 | 1·85 | ·27 | 1·23 | ·62 | ·17 | 5·3 | 35·5 | 8·40 | Bush. |
| | | May, 1935 | ·14 | 1·49 | ·50 | 1·69 | ·82 | ·52 | 6·7 | 37·0 | 8·66 | Bush. |
| | | Aug., 1935 | ·17 | 1·68 | ·34 | 2·35 | 1·75 | 1·10 | 10·5 | 26·8 | 11·53 | Bush. |
| Uitkyk.......... | Jansenville..... | Dec., 1934 | ·19 | 1·12 | ·36 | 1·59 | 1·37 | ·57 | 9·8 | 35·3 | 9·80 | Bush. |
| | | Mar., 1935 | ·11 | ·85 | ·25 | 1·15 | ·44 | ·23 | 7·0 | 40·2 | 5·58 | Bush. |
| | | June, 1935 | ·23 | 1·31 | ·56 | 2·41 | ·95 | ·60 | 9·6 | 28·9 | 9·52 | Bush. |
| | | Sept., 1935 | ·16 | ·88 | ·30 | 1·52 | 2·01 | 1·48 | 7·9 | 33·5 | 10·15 | Bush. |
| Nuwefontein..... | Jansenville..... | Jan., 1935 | ·14 | ·95 | ·25 | 1·47 | ·39 | ·39 | 6·3 | 36·6 | 5·43 | Bush. |
| | | April, 1935 | ·15 | 1·65 | ·47 | 1·15 | ·73 | ·49 | 6·4 | 34·1 | 8·24 | Bush. |
| | | July, 1935 | ·15 | 1·55 | ·53 | 1·49 | ·46 | ·50 | 8·3 | 36·9 | 8·46 | Bush. |
| | | Oct., 1935 | ·19 | 1·43 | ·58 | 2·12 | 1·02 | 1·25 | 9·1 | 28·5 | 8·86 | Bush. |
| Vogelstruislaagte. | Willowmore.... | Nov., 1934 | ·066 | ·61 | ·21 | ·81 | ·32 | ·14 | 5·3 | 46·8 | 3·88 | Bush. |
| | | May, 1935 | ·15 | ·79 | ·17 | 1·40 | ·56 | ·21 | 6·4 | 40·9 | 5·28 | Bush. |
| | | Aug., 1935 | ·13 | 1·36 | ·25 | 1·11 | ·76 | ·57 | 7·9 | 37·9 | 6·78 | Bush. |
| Finchley......... | Willowmore.... | Dec., 1934 | ·14 | ·83 | ·38 | 1·47 | 2·47 | ·88 | 9·2 | 27·5 | 11·45 | Bush. |
| | | Mar., 1935 | ·10 | 1·12 | ·51 | 1·10 | 3·96 | 2·82 | 7·0 | 30·7 | 15·83 | Bush. |
| | | June, 1935 | ·17 | ·56 | ·41 | 1·41 | 3·24 | ·45 | 10·2 | 29·0 | 12·02 | Bush. |
| | | Sept., 1935 | ·14 | ·74 | ·21 | 1·34 | 1·18 | ·69 | 8·9 | 38·0 | 7·26 | Bush. |
| Laughingwaters.. | Willowmore.... | Jan., 1935 | ·16 | ·45 | ·24 | 1·22 | 1·77 | ·80 | 7·0 | 34·7 | 8·88 | Bush. |
| | | April, 1935 | ·19 | ·52 | ·33 | ·69 | 1·65 | ·38 | 7·5 | 39·6 | 6·96 | Bush. |
| | | July, 1935 | ·18 | ·59 | ·23 | 1·24 | ·88 | ·58 | 7·2 | 43·2 | 5·63 | Bush. |
| | | Oct., 1935 | ·17 | ·75 | ·30 | 1·21 | ·80 | ·57 | 8·0 | 38·5 | 6·12 | Bush. |

## AREA 15 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Koeniilaagte..... | Willowmore.... | Nov., 1934 | ·14 | 1·04 | ·55 | 1·69 | 3·03 | 2·05 | 10·2 | 22·3 | 15·10 | Bush. |
| | | Feb., 1935 | ·14 | ·69 | ·30 | 1·31 | 1·76 | ·78 | 6·7 | 34·4 | 8·63 | Bush. |
| | | May, 1935 | ·11 | ·75 | ·29 | 1·12 | 1·78 | 1·84 | 5·8 | 40·5 | 8·95 | Bush. |
| | | Aug., 1935 | ·20 | 1·01 | ·58 | 2·35 | 3·37 | 3·06 | 11·7 | 28·1 | 13·84 | Bush. |
| Thorndale........ | Willowmore.... | Dec., 1934 | ·20 | ·98 | ·37 | 2·97 | 3·06 | ·15 | 12·4 | 24·4 | 15·22 | Bush. |
| | | Mar., 1935 | ·098 | 1·07 | ·56 | 1·33 | 1·24 | 1·05 | 9·5 | 34·4 | 8·16 | Bush. |
| | | June, 1935 | ·12 | 1·08 | ·40 | 1·08 | 1·35 | ·60 | 7·9 | 36·7 | 8·02 | Bush. |
| | | Sept., 1935 | ·15 | 1·72 | ·72 | 1·76 | 2·18 | 2·73 | 9·3 | 28·3 | 14·72 | Bush. |
| Suidwaaikraal.... | Willowmore.... | Jan., 1935 | ·12 | ·93 | ·46 | 1·81 | 2·46 | 2·30 | 8·2 | 31·4 | 12·17 | Bush. |
| | | April, 1935 | ·13 | ·61 | ·23 | 1·26 | ·39 | ·25 | 6·3 | 38·3 | 5·20 | Bush. |
| | | July, 1935 | ·15 | ·83 | ·32 | 1·45 | 1·34 | 1·15 | 8·4 | 37·1 | 8·25 | Bush. |
| | | Oct., 1935 | ·14 | 1·12 | ·25 | 2·41 | 2·10 | 2·29 | 8·5 | 32·8 | 13·35 | Bush. |
| Balieskraal....... | Aberdeen...... | Nov., 1934 | ·19 | 1·11 | ·50 | 2·40 | 1·70 | 1·72 | 13·1 | 27·5 | 11·65 | Bush. |
| | | Feb., 1935 | ·25 | 1·12 | ·30 | 1·88 | 1·14 | 1·08 | 10·7 | 33·3 | 8·90 | Bush. |
| | | July, 1935 | ·20 | ·79 | ·29 | 1·70 | ·72 | ·54 | 8·7 | 38·5 | 6·40 | Bush. |
| | | Oct., 1935 | ·19 | ·94 | ·38 | 2·70 | 2·17 | 1·76 | 8·5 | 30·4 | 12·25 | Bush. |
| Kraairivier....... | Aberdeen...... | Dec., 1934 | ·26 | ·89 | ·46 | 3·17 | 2·18 | 1·37 | 12·5 | 30·0 | 13·34 | Bush. |
| | | Mar., 1935 | ·23 | 1·01 | ·55 | 2·48 | 1·73 | 1·59 | 11·0 | 34·6 | 11·80 | Bush. |
| | | Sept., 1935 | ·29 | ·79 | ·60 | 5·78 | 3·85 | 2·07 | 18·2 | 18·5 | 22·20 | Bush. |
| Bassonskraal..... | Aberdeen...... | Jan., 1935 | ·18 | ·84 | ·56 | 1·93 | 3·04 | 2·96 | 13·1 | 25·6 | 14·80 | Bush. |
| | | April, 1935 | ·17 | 1·24 | ·59 | 1·52 | 1·82 | 1·38 | 10·1 | 30·6 | 10·62 | Bush. |
| | | Aug., 1935 | ·30 | 1·02 | ·68 | 2·70 | 4·01 | 3·50 | 15·8 | 23·9 | 17·90 | Bush. |
| | | Nov., 1935 | ·14 | ·74 | ·41 | 2·35 | 2·96 | 1·36 | 10·5 | 29·7 | 14·93 | Bush. |
| Rodeblom........ | Graaff-Reinet... | Nov., 1934 | ·13 | ·42 | ·12 | ·96 | ·25 | ·20 | 5·2 | 42·2 | 3·10 | Grass and bush; mostly bush. |
| | | Feb., 1935 | ·16 | ·41 | ·13 | 1·23 | ·26 | ·22 | 6·2 | 37·8 | 3·30 | Grass, mainly green, and bush. |
| | | May, 1935 | ·12 | ·37 | ·10 | ·84 | ·25 | ·15 | 5·2 | 39·5 | 2·42 | Grass, brown, and bush. |
| | | Aug., 1935 | ·12 | ·80 | ·37 | 1·34 | ·70 | ·36 | 7·2 | 29·8 | 5·54 | Bush. |
| Dalham.......... | Graaff-Reinet... | Dec., 1934 | ·17 | ·61 | ·37 | 1·76 | 1·27 | 1·20 | 8·1 | 33·5 | 7·31 | Grass, brown, and bush. |
| | | Mar., 1935 | ·093 | ·67 | ·29 | 2·70 | ·54 | ·68 | 11·7 | 32·1 | 6·90 | Grass, green, and bush; mostly grass. |
| | | June, 1935 | ·14 | ·59 | ·25 | 1·66 | ·62 | ·54 | 9·2 | 36·7 | 4·88 | Grass and bush. |
| | | Sept., 1935 | ·16 | ·74 | ·24 | 1·51 | ·59 | ·72 | 8·8 | 34·2 | 5·71 | Grass, and bush. |
| Riversdale....... | Graaff-Reinet... | Jan., 1935 | ·18 | ·74 | ·51 | 2·78 | ·98 | 1·23 | 9·3 | 32·4 | 9·20 | Grass, brown, and bush. |
| | | April, 1935 | ·25 | 1·14 | ·38 | 2·82 | ·50 | ·81 | 11·2 | 27·9 | 8·36 | Grass, mainly green, and bush. |
| | | July, 1935 | ·16 | 1·25 | ·45 | 1·40 | ·68 | ·25 | 9·7 | 30·2 | 7·22 | Bush. |
| | | Oct., 1935 | ·19 | ·74 | ·31 | 1·07 | ·33 | ·22 | 7·5 | 34·8 | 4·58 | Grass, mainly green, and bush. |

AREA 15 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Golden Valley.... | Tarka.......... | Dec., 1933 | ·18 | ·20 | ·11 | 1·47 | ·05 | ·34 | 10·0 | 36·6 | 3·36 | Grass, green. |
| | | Mar., 1934 | ·16 | ·37 | ·15 | ·79 | trace | ·19 | 5·4 | 35·6 | 2·46 | Grass. |
| | | June, 1934 | ·11 | ·29 | ·08 | ·49 | ·01 | ·09 | 4·6 | 36·7 | 1·97 | Grass, mainly brown, and bush. mostly grass. |
| | | Sept., 1934 | ·09 | ·21 | ·04 | ·26 | trace | ·07 | 3·7 | 36·3 | 1·25 | Grass, mainly brown. |
| | | Dec., 1934 | ·14 | ·33 | ·14 | 1·08 | ·04 | ·18 | 6·2 | 33·5 | 2·53 | Grass, mainly green, and bush; mostly grass. |
| | | Mar., 1935 | ·11 | ·24 | ·07 | ·62 | ·01 | ·16 | 5·2 | 28·8 | 2·65 | Grass, mainly green, short. |
| | | June, 1935 | ·11 | ·28 | ·10 | ·60 | ·02 | ·14 | 6·3 | 38·4 | 2·45 | Grass, short. and bush; mostly grass. |
| | | Sept., 1935 | ·14 | ·46 | ·10 | ·82 | ·03 | ·14 | 7·4 | 29·1 | 3·60 | Grass, mainly green, short, and bush. |
| Morning Sun..... | Tarka.......... | Jan., 1934 | ·23 | ·34 | ·18 | 2·16 | ·03 | ·34 | 9·2 | 37·4 | 4·80 | Grass, mainly green, and bush; mostly grass. |
| | | April, 1934 | ·19 | ·89 | ·50 | 2·95 | ·07 | ·60 | 10·6 | 28·7 | 8·38 | Grass, mainly brown, and bush. |
| | | July, 1934 | ·15 | ·75 | ·17 | ·85 | ·01 | ·12 | 5·3 | 34·8 | 3·40 | Grass, brown, leafy, and bush; mostly grass. |
| | | Oct., 1934 | ·068 | ·43 | ·10 | ·43 | ·02 | ·03 | 3·8 | 36·6 | 1·82 | Grass, brown, leafy, and bush. |
| | | Jan., 1935 | ·12 | ·42 | ·12 | 1·42 | ·04 | ·26 | 5·3 | 35·6 | 3·08 | Grass, mainly brown, and bush; mostly grass. |
| | | April, 1935 | ·16 | ·47 | ·18 | 1·47 | ·14 | ·24 | 8·9 | 31·2 | 3·82 | Grass, mainly green, short, and bush. |
| | | July, 1935 | ·15 | ·83 | ·31 | 1·28 | ·19 | ·25 | 7·2 | 38·1 | 4·93 | Bush. |
| | | Oct., 1935 | ·12 | ·78 | ·36 | 2·42 | ·03 | ·49 | 12·3 | 30·0 | 6·43 | Grass, mainly brown, short, and bush. |
| Middelkraal...... | Tarka.......... | Nov., 1933 | ·14 | ·74 | ·22 | 1·39 | ·05 | ·27 | 9·6 | 34·0 | 5·56 | Bush. |
| | | Feb., 1934 | ·27 | ·38 | ·15 | 1·52 | ·04 | ·18 | 5·7 | 35·4 | 3·72 | Grass, mainly green, and bush; mostly grass. |
| | | May, 1934 | ·25 | ·48 | ·20 | 1·31 | ·04 | ·15 | 6·3 | 31·5 | 3·97 | Grass, mainly brown, and bush. |
| | | Aug., 1934 | ·13 | ·88 | ·27 | 1·49 | ·04 | ·16 | 7·9 | 35·3 | 5·19 | Bush. |
| | | Nov., 1934 | ·087 | ·28 | ·08 | ·60 | trace | ·07 | 3·9 | 37·9 | 1·84 | Grass, mainly brown, and bush. |
| | | Feb., 1935 | ·15 | ·30 | ·09 | 1·45 | trace | ·17 | 7·5 | 36·6 | 3·02 | Grass, mainly green, short, and bush; mostly grass. |
| | | May, 1935 | ·13 | ·73 | ·18 | 1·55 | ·11 | ·22 | 7·8 | 37·9 | 4·36 | Grass, mainly green, and bush; mostly bush. |
| | | Aug., 1935 | ·13 | ·73 | ·21 | 1·33 | ·23 | ·16 | 8·2 | 38·8 | 4·25 | Bush. |
| Rustenburg...... | Pearston....... | Dec., 1934 | ·21 | 1·15 | ·51 | 2·94 | 3·07 | 3·18 | 11·2 | 27·6 | 15·22 | Bush. |
| | | Mar., 1935 | ·14 | ·76 | ·41 | 1·75 | 2·48 | 2·37 | 10·8 | 31·3 | 11·67 | Bush. |
| | | June, 1935 | ·26 | 1·06 | ·64 | 2·09 | 3·05 | 2·76 | 15·9 | 19·5 | 14·18 | Bush. |
| | | Sept., 1935 | ·30 | ·76 | ·75 | 2·56 | 4·12 | 4·11 | 15·0 | 21·3 | 18·18 | Bush. |

## AREA 15 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Alleengelaten (Bradley)** | Pearston....... | Jan., 1935 | ·12 | ·92 | ·95 | 2·19 | 3·20 | 3·80 | 9·5 | 31·3 | 15·54 | Bush. |
| | | April, 1935 | ·16 | 1·07 | ·60 | 2·11 | 3·12 | 1·64 | 11·2 | 25·5 | 14·95 | Bush. |
| | | Aug., 1935 | ·18 | ·81 | ·24 | 1·13 | ·68 | ·46 | 8·4 | 37·4 | 5·72 | Bush. |
| | | Sept., 1935 | ·29 | 1·46 | ·62 | 2·39 | 6·32 | 9·02 | 9·5 | 18·8 | 27·20 | Bush. |
| **Alleengelaten (Momberg)** | Pearston....... | Feb., 1935 | ·12 | ·75 | ·16 | 1·05 | ·87 | ·46 | 7·9 | 43·8 | 5·66 | Bush. |
| | | May, 1935 | ·22 | ·82 | ·38 | 2·38 | 3·13 | 1·16 | 10·0 | 37·2 | 13·98 | Bush. |
| | | July, 1935 | ·25 | ·92 | ·43 | 2·62 | 3·07 | 2·66 | 13·2 | 27·0 | 14·46 | Bush. |
| **Plankfontein.....** | Cradock....... | Nov., 1933 | ·11 | 1·22 | ·18 | 1·20 | ·43 | ·23 | 9·6 | 31·5 | 6·10 | Bush. |
| | | Feb., 1934 | ·18 | 1·08 | ·25 | 1·49 | ·41 | ·41 | 9·1 | 29·0 | 6·03 | Grass, green, short, and bush; mostly bush. |
| | | May, 1934 | ·15 | ·51 | ·13 | 1·25 | ·63 | — | 6·1 | 44·7 | 4·52 | Bush. |
| | | Aug., 1934 | ·12 | ·68 | — | 1·26 | ·28 | ·15 | 5·4 | 41·4 | 4·56 | Bush. |
| | | Nov., 1934 | ·084 | ·69 | ·16 | 1·02 | ·19 | ·16 | 6·1 | 48·3 | 4·00 | Bush. |
| | | Feb., 1935 | ·13 | ·94 | ·11 | 1·15 | ·10 | ·11 | 6·7 | 40·7 | 4·35 | Grass, mainly green, short, and bush; mostly bush. |
| | | May, 1935 | ·13 | ·72 | ·17 | 1·46 | ·16 | ·30 | 7·1 | 41·5 | 4·52 | Bush. |
| | | Aug., 1935 | ·13 | 1·29 | ·20 | 1·25 | ·11 | ·25 | 7·9 | 34·5 | 6·02 | Bush. |
| **Waaikraal.......** | Cradock....... | Dec., 1933 | ·13 | 1·14 | ·21 | 1·23 | ·53 | ·45 | 11·5 | — | 6·76 | Bush. |
| | | Mar., 1934 | ·27 | ·77 | ·27 | 2·07 | 1·58 | 1·07 | 14·5 | 30·0 | 9·58 | Grass, green, short, and bush. |
| | | June, 1934 | ·17 | ·57 | ·25 | 1·38 | 1·04 | ·40 | 8·6 | 35·9 | 5·36 | Grass, mainly green, and bush; mostly grass. |
| | | Sept., 1934 | ·096 | ·28 | ·10 | ·76 | ·04 | ·30 | 6·4 | 34·2 | 1·91 | Grass, mainly brown, leafy. |
| | | Dec., 1934 | ·19 | ·80 | ·22 | 1·65 | ·77 | ·53 | 13·6 | 30·1 | 6·34 | Bush. |
| | | Mar., 1935 | ·18 | ·37 | ·25 | 1·34 | ·69 | ·30 | 8·9 | 34·3 | 4·69 | Grass, short. |
| | | June, 1935 | ·20 | 1·08 | ·38 | 2·00 | 1·90 | ·71 | 11·6 | 28·1 | 9·96 | Bush. |
| | | Sept., 1935 | ·16 | 1·40 | ·70 | 1·93 | ·71 | ·75 | 9·5 | 34·2 | 9·74 | Bush. |
| **Zuurfontein......** | Cradock....... | Jan., 1934 | ·38 | 1·02 | ·61 | 5·73 | ·89 | 1·41 | 18·1 | 21·2 | 14·90 | Bush. |
| | | April, 1934 | ·17 | ·61 | ·21 | 1·46 | ·02 | ·18 | 6·2 | 38·7 | 4·58 | Grass, short, and bush. |
| | | July, 1934 | ·12 | ·46 | ·14 | ·88 | ·02 | ·09 | 6·2 | 37·8 | 2·97 | Grass, brown, short ,and bush. |
| | | Oct., 1934 | ·072 | ·42 | ·11 | ·64 | ·06 | ·06 | 4·3 | 45·7 | 2·24 | Bush. |
| | | Jan., 1935 | — | ·66 | ·10 | ·98 | ·10 | — | 5·6 | 42·8 | 3·70 | Bush. |
| | | April, 1935 | ·14 | ·95 | ·31 | 1·83 | ·06 | ·20 | 8·3 | 36·4 | 5·54 | Bush. |
| | | July, 1935 | ·14 | ·51 | ·16 | 1·18 | ·03 | ·10 | 6·6 | 46·6 | 3·63 | Bush. |
| | | Oct., 1935 | ·13 | ·55 | ·16 | 1·17 | ·04 | ·09 | 5·7 | 37·3 | 3·32 | Bush. |

## Area 16.

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Griquatown Town Lands | Hay........... | Feb., 1934 | ·15 | ·47 | ·15 | 1·53 | ·03 | ·29 | 7·8 | 35·4 | 3·46 | Grass, mainly green. |
| | | May, 1934 | ·12 | 2·01 | ·43 | 1·08 | ·02 | ·14 | 9·8 | 31·2 | 7·15 | Grass, mainly brown, and bush; mostly bush. |
| | | Aug., 1934 | ·06 | 1·55 | ·32 | 1·08 | ·01 | ·10 | 6·7 | 33·9 | 5·86 | Bush. |
| | | Nov., 1934 | ·14 | ·81 | ·28 | 2·13 | ·03 | ·44 | 11·7 | 35·0 | 5·46 | Grass, green, and bush; mostly, grass. |
| | | Feb., 1935 | ·10 | ·65 | ·13 | 1·07 | trace | ·21 | 6·0 | 35·7 | 3·20 | Grass and bush; mostly bush. |
| | | May, 1935 | ·15 | ·87 | ·20 | 1·69 | trace | ·29 | 10·3 | 29·7 | 5·32 | Grass and bush; mostly bush. |
| | | Sept., 1935 | ·073 | 1·42 | ·22 | 1·03 | ·02 | ·09 | 6·9 | 35·5 | 5·97 | Bush. |
| Rooivlei......... | Hay........... | Mar., 1934 | ·12 | ·49 | ·27 | 1·42 | ·02 | ·24 | 8·1 | 36·1 | 4·06 | Grass, mainly green. |
| | | June, 1934 | ·14 | ·92 | ·24 | 1·42 | ·02 | ·25 | 9·5 | 28·1 | 5·52 | Grass, mainly brown, and bush. |
| | | Sept., 1934 | ·09 | 1·33 | ·29 | 1·11 | ·01 | ·13 | 6·6 | 35·4 | 5·72 | Bush. |
| | | Dec., 1934 | ·12 | 1·28 | ·18 | 1·72 | ·05 | ·34 | 9·8 | 36·4 | 5·98 | Grass, green, short, and bush. |
| | | Mar., 1935 | ·13 | ·50 | ·09 | 1·04 | trace | ·45 | 6·1 | 36·7 | 3·52 | Grass and bush. |
| | | June, 1935 | ·087 | ·71 | ·15 | 1·24 | ·01 | ·14 | 7·5 | 31·5 | 3·71 | Grass, brown, and bush. |
| Kalkfontein...... | Hay........... | April, 1934 | ·18 | ·54 | ·19 | 1·14 | ·05 | ·18 | 5·4 | 32·8 | 3·05 | Grass and bush; mostly grass. |
| | | July, 1934 | ·096 | ·84 | ·18 | 1·18 | ·01 | ·22 | 7·7 | 31·9 | 4·29 | Grass, mainly brown, and bush; mostly bush. |
| | | Oct., 1934 | ·12 | ·40 | ·19 | 1·48 | ·30 | ·53 | 10·3 | 32·7 | 5·00 | Grass, green, and bush; mostly bush. |
| | | Jan., 1935 | ·08 | 1·05 | ·16 | 1·10 | ·03 | ·18 | 6·7 | 36·2 | 4·16 | Grass, mainly brown, and bush. |
| | | April, 1935 | ·12 | ·74 | ·17 | 1·65 | trace | ·19 | 9·3 | 30·9 | 4·53 | Grass, mainly green, and bush. |
| Selfdrink......... | Hay........... | April, 1934 | ·084 | ·56 | ·15 | 1·30 | trace | ·12 | 6·9 | 39·6 | 4·08 | Grass, mainly green, and bush; mostly grass. |
| | | July, 1934 | ·073 | ·91 | ·25 | 1·00 | ·05 | ·24 | 7·4 | 29·9 | 4·03 | Grass, mainly brown, and bush. |
| | | June, 1935 | ·08 | ·84 | ·22 | 1·10 | trace | ·21 | 7·5 | 31·4 | 3·98 | Bush. |
| | | Sept., 1935 | ·063 | 1·44 | ·24 | ·90 | ·08 | ·01 | 7·9 | 30·9 | 5·46 | Bush. |
| Soville........... | Hay........... | Feb., 1934 | ·15 | 1·36 | ·40 | 1·89 | ·03 | ·79 | 11·5 | 31·8 | 7·42 | Grass and bush. |
| | | June, 1934 | ·12 | 1·27 | ·31 | 1·30 | ·02 | ·33 | 11·0 | 35·2 | 5·52 | Bush. |
| | | Sept., 1934 | ·05 | ·38 | ·18 | ·86 | ·02 | ·12 | 4·8 | 39·3 | 2·36 | Grass, brown, and bush; mostly grass. |
| | | April, 1935 | ·13 | ·58 | ·18 | 1·53 | ·03 | ·32 | 7·1 | 27·4 | 3·70 | Grass and bush. |
| | | May, 1935 | ·11 | 1·13 | ·31 | 1·66 | trace | ·25 | 9·0 | 35·8 | 6·14 | Bush. |
| Donkerhoek...... | Britstown...... | Feb., 1934 | ·23 | ·39 | ·29 | 3·13 | ·15 | ·64 | 12·8 | 34·3 | 7·55 | Grass, mainly green. |
| | | May, 1934 | ·18 | ·76 | ·38 | 1·83 | 1·79 | 1·21 | 9·8 | 30·2 | 9·02 | Grass, mainly brown, and bush. |
| | | Nov., 1934 | ·15 | ·39 | ·18 | 1·71 | ·21 | ·36 | 8·3 | 33·1 | 4·23 | Grass, mainly green. |
| | | Feb., 1935 | ·13 | ·54 | ·13 | ·97 | ·07 | ·11 | 4·7 | 42·7 | 3·25 | Grass, brown, and bush; mostly bush. |
| | | May, 1935 | ·19 | ·55 | ·24 | 1·72 | ·22 | ·26 | 7·7 | 37·6 | 4·52 | Grass, mainly brown, and bush. |
| | | Aug., 1935 | ·18 | 1·41 | ·31 | 1·77 | 1·21 | ·49 | 9·6 | 29·9 | 9·54 | Bush. |

## AREA 16 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Vrolikspan** | Britstown | Mar., 1934 | ·25 | ·97 | ·43 | 2·13 | 2·03 | 1·25 | 14·1 | 26·5 | 11·25 | Grass, green, and bush. |
| | | June, 1934 | ·18 | 1·51 | ·61 | 1·42 | 2·06 | 2·02 | 14·5 | 25·3 | 14·25 | Bush. |
| | | Dec., 1934 | ·21 | 1·15 | ·45 | 2·48 | 3·20 | 2·41 | 14·4 | 25·9 | 17·40 | Bush. |
| | | Mar., 1935 | ·17 | 1·16 | ·56 | 2·16 | 1·85 | 1·89 | 12·1 | 26·7 | 12·43 | Bush. |
| | | June, 1935 | ·13 | 1·13 | ·52 | 2·09 | 3·11 | 1·13 | 11·5 | 30·9 | 14·48 | Bush. |
| | | Sept., 1935 | ·15 | 1·59 | ·44 | 1·66 | ·28 | ·18 | 9·4 | 33·2 | 8·10 | Bush. |
| **Gemsbokfontein** | Britstown | April, 1934 | ·19 | 1·32 | ·55 | 2·45 | 1·38 | 1·56 | 11·8 | 27·4 | 11·70 | Grass, mainly green, and bush; mostly bush. |
| | | Sept., 1934 | ·12 | 1·68 | ·63 | 2·19 | 2·80 | 1·80 | 10·7 | 23·7 | 16·30 | Bush. |
| | | Jan., 1935 | ·17 | ·81 | ·30 | 2·26 | 1·37 | 1·07 | 9·7 | 37·9 | 10·25 | Bush. |
| | | April, 1935 | ·15 | 1·67 | ·41 | 2·50 | 1·11 | ·77 | 10·9 | 30·8 | 10·17 | Bush. |
| | | July, 1935 | ·17 | 1·33 | ·40 | 1·45 | 1·44 | ·75 | 11·2 | 33·1 | 11·05 | Bush. |
| | | Oct., 1935 | ·19 | 1·07 | ·60 | 1·96 | 2·63 | 1·29 | 12·8 | 24·3 | 14·10 | Bush. |
| **Smousdam** | Hopetown | April, 1935 | ·15 | 1·47 | ·84 | 2·40 | 3·85 | 1·86 | 14·8 | 24·1 | 19·05 | Bush. |
| **Zoutpansput** | Hopetown | May, 1935 | ·20 | ·74 | ·26 | 2·15 | ·11 | ·54 | 11·3 | 33·3 | 5·78 | Bush. |
| **Stoffelshoek** | Hopetown | June, 1935 | ·16 | ·84 | ·29 | 2·10 | trace | ·26 | 10·3 | 26·7 | 6·24 | Bush. |
| | | Sept., 1935 | ·13 | 1·32 | ·32 | 1·12 | ·03 | ·32 | 7·6 | 42·8 | 5·82 | Bush. |
| **Kareeboomput** | Prieska | May, 1934 | ·048 | — | ·20 | 1·08 | ·02 | ·27 | 4·3 | 39·0 | 2·89 | Grass, mainly brown. |
| | | Nov., 1934 | ·20 | ·39 | ·14 | 1·72 | trace | ·14 | 7·7 | 35·0 | 3·58 | Grass, mainly green. |
| | | Mar., 1935 | ·15 | ·39 | ·13 | 1·73 | ·04 | ·36 | 6·6 | 34·5 | 3·81 | Grass, mainly green. |
| | | June, 1935 | ·077 | ·28 | ·11 | ·84 | ·01 | ·14 | 4·7 | 40·8 | 2·28 | Grass, mainly brown. |
| | | Sept., 1935 | ·085 | ·41 | ·17 | 1·19 | ·03 | ·24 | 6·0 | 36·7 | 3·07 | Grass, mainly brown. |
| **Blaauwputs** | Prieska | Mar., 1934 | ·18 | ·39 | ·20 | 1·98 | ·05 | ·35 | 9·6 | 32·4 | 4·09 | Grass, green. |
| | | June, 1934 | ·078 | ·28 | ·10 | ·52 | ·01 | ·06 | 2·8 | 42·0 | 1·83 | Grass, brown, long. |
| | | Dec., 1934 | ·05 | ·24 | ·08 | ·24 | trace | Trace | 2·9 | 40·3 | 1·49 | Grass, mainly brown. |
| | | April, 1935 | ·13 | ·50 | ·16 | 1·31 | trace | ·15 | 8·7 | 32·6 | 3·41 | Grass, mainly green. |
| | | Aug., 1935 | ·15 | ·68 | ·24 | 2·70 | ·19 | 1·22 | 6·0 | 28·6 | 7·50 | Grass, brown, and shrub. |
| **Marydale Town Lands** | Prieska | April, 1934 | ·17 | ·44 | ·16 | 1·46 | ·04 | ·22 | 7·2 | 35·7 | 3·93 | Grass, mainly green. |
| | | July, 1934 | — | ·37 | ·14 | ·93 | ·03 | ·08 | 3·3 | 36·9 | 2·62 | Grass, brown, long. |
| | | Oct., 1934 | ·082 | ·37 | ·12 | ·51 | ·01 | ·04 | 2·8 | 37·7 | 1·76 | Grass, brown, long. |
| | | Jan., 1935 | ·11 | ·26 | ·12 | 1·17 | ·02 | ·24 | 5·3 | 40·4 | 2·46 | Grass, mainly green, long. |
| | | May, 1935 | ·087 | ·35 | ·12 | ·89 | trace | ·13 | 5·9 | 37·7 | 2·34 | Grass, mainly brown. |
| | | July, 1935 | ·12 | ·39 | ·13 | 1·15 | ·03 | ·19 | 5·6 | 40·1 | 2·76 | Grass, brown. |
| | | Oct., 1935 | ·076 | ·53 | ·14 | 1·01 | ·04 | ·15 | 4·7 | 39·2 | 2·88 | Grass, brown. |

Area 16 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ramskop........ | Calvinia....... | Nov., 1934 | ·15 | ·90 | ·30 | 1·16 | 1·02 | ·60 | 7·7 | 36·1 | 7·04 | Bush. |
| | | Feb., 1935 | ·094 | 1·30 | ·65 | 1·80 | 2·97 | ·96 | 9·1 | 29·0 | 14·10 | Bush. |
| | | May, 1935 | ·15 | 1·07 | ·39 | 1·22 | 2·56 | 1·19 | 8·8 | 33·3 | 12·06 | Bush. |
| | | Aug., 1935 | ·17 | 1·33 | ·68 | 1·50 | 2·42 | 1·47 | 7·8 | 29·7 | 12·28 | Bush. |
| Wilgenbos....... | Calvinia....... | Jan., 1935 | ·13 | ·95 | ·53 | 1·83 | 2·44 | 2·49 | 8·7 | 31·0 | 14·20 | Bush. |
| | | Mar., 1935 | ·14 | ·97 | ·40 | ·98 | 1·23 | ·68 | 8·9 | 43·5 | 7·64 | Bush. |
| | | June, 1935 | ·14 | 1·15 | ·44 | 1·39 | 1·36 | 1·05 | 11·9 | 31·4 | 9·06 | Bush. |
| | | Sept., 1935 | ·27 | ·68 | ·34 | 2·37 | 4·10 | 1·12 | 10·4 | 24·3 | 16·50 | Bush. |
| Weltevrede....... | Calvinia..... | Feb., 1935 | ·14 | 1·23 | ·69 | 1·74 | 3·98 | ·40 | 8·7 | 24·6 | 17·35 | Bush. |
| | | April, 1935 | ·10 | 1·29 | ·57 | 1·50 | 5·40 | 2·32 | 9·2 | 23·8 | 21·44 | Bush. |
| | | July, 1935 | ·20 | 1·30 | ·70 | 2·29 | 2·66 | 2·30 | 11·9 | 30·9 | 15·47 | Bush. |
| | | Oct., 1935 | ·14 | ·80 | ·42 | 1·79 | 2·53 | 1·60 | 7·5 | 34·7 | 12·10 | Bush. |
| Die Hoop........ | Calvinia....... | Nov., 1934 | ·16 | 1·25 | ·36 | 2·23 | ·30 | ·51 | 10·4 | 26·2 | 8·20 | Bush. |
| | | Feb., 1935 | ·11 | ·48 | ·16 | ·93 | ·14 | ·20 | 5·1 | 36·3 | 2·81 | Grass, brown, and bush; mostly bush. |
| | | May, 1935 | ·13 | 1·13 | ·31 | ·84 | ·08 | ·23 | 9·6 | 32·8 | 6·21 | Bush. |
| | | Aug., 1935 | ·15 | ·85 | ·42 | 1·19 | ·55 | ·64 | 10·6 | 24·8 | 5·56 | Bush. |
| Kuilwater........ | Calvinia....... | Dec., 1934 | ·10 | ·59 | ·21 | 1·06 | ·83 | ·38 | 7·5 | 36·4 | 4·65 | Grass, and bush. |
| | | Mar., 1935 | ·12 | ·51 | ·22 | 1·05 | ·34 | ·38 | 6·9 | 43·8 | 3·65 | Grass, mainly green, and bush; mostly bush. |
| | | June, 1935 | ·11 | ·70 | ·21 | 1·07 | ·28 | ·24 | 7·3 | 34·6 | 4·42 | Bush. |
| | | Sept., 1935 | ·28 | 1·00 | ·30 | 2·08 | ·81 | ·91 | 12·8 | 27·5 | 8·27 | Bush. |
| Leeuwfontein..... | Calvinia....... | Jan., 1935 | ·22 | ·72 | ·43 | 1·79 | 1·35 | 1·73 | 10·5 | 30·5 | 8·00 | Grass, mainly green, and bush; mostly bush. |
| | | April, 1935 | ·12 | ·75 | ·21 | 1·26 | ·64 | ·33 | 6·3 | 40·3 | 5·66 | Bush. |
| | | July, 1935 | ·14 | 1·35 | ·53 | 1·19 | ·92 | ·53 | 8·2 | 33·9 | 8·36 | Bush. |
| | | Oct., 1935 | ·095 | ·82 | ·43 | 1·03 | ·83 | ·37 | 4·8 | 41·3 | 6·24 | Bush. |
| Dikdoorns....... | Calvinia....... | Dec., 1934 | ·13 | ·82 | ·21 | 1·78 | ·53 | ·38 | 7·5 | 41·9 | 6·50 | Bush. |
| | | Mar., 1935 | ·19 | 2·05 | ·38 | 1·94 | ·32 | ·46 | 11·5 | 36·7 | 9·54 | Bush. |
| | | Sept., 1935 | ·10 | 1·66 | ·33 | ·92 | ·66 | ·27 | 8·1 | 35·0 | 9·08 | Bush. |
| Gansfontein...... | Fraserburg..... | Oct., 1934 | ·12 | 1·10 | ·30 | 1·10 | 1·01 | ·36 | 8·3 | 30·6 | 7·30 | Bush. |
| | | Feb., 1935 | ·16 | ·81 | ·25 | 1·55 | ·54 | ·29 | 6·7 | 36·4 | 6·14 | Bush. |
| | | May, 1935 | ·18 | ·97 | ·36 | 2·34 | 1·37 | ·98 | 8·4 | 34·5 | 10·50 | Bush. |
| | | Oct., 1935 | ·18 | ·97 | ·39 | 2·06 | 1·53 | ·70 | 6·4 | 34·0 | 9·84 | Bush. |

## AREA 16 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goedverwachting. | Fraserburg..... | Dec., 1934 | ·11 | 1·06 | ·19 | 1·89 | 1·70 | ·79 | 7·1 | 29·3 | 10·34 | Grass, mainly green, short, and bush. |
| | | Mar., 1935 | ·22 | ·63 | ·24 | 1·74 | ·24 | ·26 | 8·1 | 33·6 | 4·86 | Bush. |
| | | June, 1935 | ·12 | 1·03 | ·37 | 1·66 | 1·36 | ·64 | 10·5 | 30·5 | 9·42 | Bush. |
| | | July, 1935 | ·14 | 1·03 | ·32 | 2·21 | 1·40 | ·68 | 11·2 | 35·2 | 10·55 | Bush. |
| Quaggafontein.... | Fraserburg..... | Jan., 1935 | ·18 | ·97 | ·31 | 2·10 | ·69 | ·52 | 8·5 | 32·6 | 7·51 | Bush. |
| | | April, 1935 | ·17 | ·92 | ·25 | 1·98 | ·68 | ·39 | 7·7 | 33·6 | 6·62 | Bush. |
| | | Sept., 1935 | ·17 | ·91 | ·29 | 1·98 | ·91 | ·45 | 8·6 | 31·9 | 7·96 | Bush. |
| Leeuwkraal...... | Fraserburg..... | Oct., 1934 | ·13 | 1·08 | ·37 | 1·52 | 1·01 | ·75 | 9·6 | 30·6 | 8·14 | Bush. |
| | | Jan., 1935 | ·10 | 1·02 | ·24 | 1·26 | 1·36 | ·62 | 6·5 | 35·2 | 8·60 | Bush. |
| Ratelfontein...... | Fraserburg..... | Nov., 1934 | ·07 | ·58 | ·17 | ·84 | ·40 | ·20 | 6·1 | 35·8 | 4·06 | Bush. |
| | | Mar., 1935 | ·20 | 1·15 | ·37 | 1·86 | ·66 | ·45 | 10·9 | 40·5 | 7·50 | Bush. |
| | | June, 1935 | ·20 | 1·18 | ·29 | 1·58 | ·29 | ·41 | 12·1 | 37·0 | 6·68 | Bush. |
| | | July, 1935 | ·19 | ·96 | ·28 | 1·63 | ·42 | ·50 | 9·5 | 34·9 | 6·70 | Bush. |
| Vliekraal......... | Fraserburg..... | Dec., 1934 | ·089 | ·73 | ·19 | ·99 | ·46 | ·17 | 6·4 | 38·3 | 4·90 | Bush. |
| | | Feb., 1935 | ·15 | ·73 | ·14 | 1·21 | ·28 | ·15 | 5·8 | 44·3 | 4·71 | Bush. |
| | | April, 1935 | ·14 | ·74 | ·30 | 1·51 | 1·24 | ·50 | 7·7 | 29·7 | 7·96 | Bush. |
| | | Aug., 1935 | ·18 | ·65 | ·31 | 1·90 | 1·53 | ·08 | 7·5 | 37·9 | 8·75 | Bush. |
| | | Sept., 1935 | ·17 | ·98 | ·30 | 2·05 | 2·21 | 1·12 | 10·1 | 31·1 | 12·33 | Bush. |
| Lower Pampoenpoort | Victoria West.. | Oct., 1934 | ·15 | ·57 | ·40 | 1·59 | 3·47 | 1·79 | 7·8 | 29·1 | 12·70 | Bush. |
| | | Jan., 1935 | ·11 | ·92 | ·30 | 1·55 | ·36 | ·75 | 8·1 | 36·9 | 5·76 | Grass and bush; mostly bush. |
| | | April, 1935 | ·18 | 1·19 | ·47 | 2·10 | ·48 | ·37 | 10·3 | 27·8 | 7·63 | Bush. |
| | | July, 1935 | ·20 | ·91 | ·27 | 1·48 | ·50 | ·45 | 12·1 | 30·3 | 6·26 | Bush. |
| | | Oct., 1935 | — | ·93 | ·53 | 1·71 | ·84 | — | 7·4 | 33·4 | 7·08 | Grass, brown, and bush. |
| Marthasput...... | Victoria West.. | Nov., 1934 | ·14 | ·96 | ·26 | 1·84 | ·55 | ·31 | 10·1 | 32·3 | 6·60 | Bush. |
| | | Feb., 1935 | ·13 | ·80 | ·22 | 1·26 | ·31 | ·24 | 6·0 | 38·0 | 5·02 | Grass, mainly brown, and bush; mostly bush. |
| | | May, 1935 | ·16 | ·80 | ·17 | 1·44 | ·32 | ·15 | 8·2 | 33·2 | 5·03 | Bush. |
| | | Aug., 1935 | ·16 | 1·01 | ·24 | 1·36 | ·56 | ·46 | 10·7 | 33·2 | 5·84 | Bush. |

AREA 16 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Beyersfontein.... | Victoria West.. | Dec., 1934 | ·18 | ·68 | ·40 | 2·53 | ·68 | ·71 | 10·2 | 38·0 | 7·83 | Grass, brown, and bush; mostly bush. |
| | | Mar., 1935 | ·11 | ·46 | ·10 | ·54 | ·28 | ·07 | 5·7 | 44·5 | 2·55 | Grass and bush. |
| | | June, 1935 | ·14 | 1·53 | ·26 | 1·34 | ·40 | ·26 | 8·0 | 34·4 | 5·36 | Bush. |
| | | Sept., 1935 | ·12 | ·82 | ·31 | 1·38 | ·20 | ·11 | 7·8 | 38·8 | 4·64 | Grass and bush; mostly bush. |
| Leeuwfontein..... | Victoria West.. | Nov., 1934 | ·10 | ·74 | ·22 | 1·42 | ·71 | ·49 | 9·3 | 33·8 | 5·89 | Bush. |
| | | Feb., 1935 | ·19 | ·91 | ·31 | 1·70 | ·30 | ·36 | 8·2 | 34·2 | 5·53 | Grass, mainly green, and bush; mostly bush. |
| | | May. 1935 | ·13 | ·66 | ·30 | 1·37 | ·32 | ·23 | 8·8 | 41·0 | 4·57 | Grass, short, and bush; mostly bush. |
| Driefontein....... | Victoria West.. | Dec., 1934 | ·15 | ·71 | ·25 | 2·28 | ·60 | ·55 | 10·5 | 34·1 | 6·46 | Grass and bush. |
| | | June, 1935 | ·17 | 1·27 | ·57 | 2·72 | 2·50 | 3·06 | 12·1 | 25·7 | 14·38 | Bush. |
| | | Sept., 1935 | ·21 | ·97 | ·35 | 1·84 | 1·00 | ·58 | 10·7 | 30·7 | 8·34 | Bush. |
| Sandaar......... | Victoria West.. | Jan., 1935 | ·20 | ·65 | ·44 | 2·16 | 1·23 | 1·65 | 10·9 | 31·3 | 8·40 | Grass, green, and bush. |
| | | April, 1935 | ·12 | ·57 | ·27 | 1·21 | 1·12 | ·63 | 7·7 | 36·7 | 6·42 | Bush. |
| | | Oct., 1935 | ·17 | 1·23 | ·41 | 1·99 | ·53 | ·47 | 7·9 | 32·7 | 7·12 | Bush. |
| Toonseplaas...... | Sutherland..... | Dec., 1934 | ·13 | ·78 | ·24 | 1·98 | 1·52 | ·72 | 10·1 | 29·0 | 9·40 | Bush. |
| | | Feb., 1935 | ·12 | ·51 | ·10 | ·87 | ·15 | ·10 | 5·3 | 37·6 | 4·47 | Bush. |
| | | May, 1935 | ·29 | 1·15 | ·43 | 2·50 | ·30 | ·64 | 12·9 | 29·7 | 8·26 | Bush. |
| | | Aug., 1935 | ·27 | 1·21 | ·35 | 2·26 | ·41 | ·57 | 11·9 | 27·1 | 8·02 | Bush. |
| Vyffontein....... | Sutherland..... | Dec., 1934 | ·12 | ·89 | ·30 | 1·45 | 1·34 | ·74 | 9·4 | 28·7 | 9·78 | Bush. |
| | | Mar., 1935 | ·31 | 1·28 | ·34 | — | ·14 | ·65 | 12·2 | 31·1 | 9·10 | Grass, mainly brown, short, and mostly bush. |
| | | June. 1935 | ·17 | 1·13 | ·32 | 1·80 | ·36 | ·64 | 11·3 | 27·4 | 7·23 | Bush. |
| | | Sept., 1935 | ·29 | ·96 | ·27 | 2·77 | ·27 | ·79 | 13·9 | 23·4 | 7·96 | Bush. |
| Snyderspost...... | Sutherland..... | Jan., 1935 | ·11 | ·57 | ·35 | 1·59 | 1·13 | ·29 | 7·5 | 38·8 | 7·56 | Bush. |
| | | April. 1935 | ·14 | ·67 | ·32 | 1·69 | 1·29 | 1·02 | 8·3 | 38·8 | 8·32 | Bush. |
| | | Oct., 1935 | ·20 | 1·07 | ·43 | 2·14 | 1·21 | ·96 | 9·0 | 29·3 | 9·52 | Bush. |
| Inverurie........ | Beaufort West. | Nov., 1934 | ·097 | ·52 | ·31 | 1·75 | 1·02 | ·37 | 6·3 | 34·3 | 6·50 | Grass, short, and bush; mostly bush. |
| | | Feb., 1935 | ·13 | ·58 | ·21 | 1·15 | 1·17 | ·54 | 6·6 | 40·2 | 6·02 | Bush. |
| | | May, 1935 | ·27 | ·92 | ·30 | 2·26 | ·76 | ·38 | 11·3 | 31·5 | 7·42 | Bush. |
| | | Aug., 1935 | ·14 | ·77 | ·26 | 1·49 | ·52 | ·24 | 7·6 | 32·3 | 5·90 | Bush. |

## AREA 16 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Snydersfontein... | Beaufort West.. | Dec., 1934 | ·20 | ·88 | ·51 | 2·68 | 4·35 | 1·86 | 13·5 | 24·6 | 18·78 | Bush. |
| | | Mar., 1935 | ·15 | ·71 | ·21 | 1·78 | ·95 | ·43 | 8·7 | 37·2 | 7·46 | Bush. |
| | | June, 1935 | ·22 | ·58 | ·33 | 2·14 | 1·52 | ·75 | 10·8 | 31·2 | 8·84 | Bush. |
| | | Sept., 1935 | ·16 | ·70 | ·25 | 1·74 | ·79 | ·47 | 9·1 | 33·4 | 6·60 | Bush. |
| Rocklands....... | Beaufort West.. | Jan., 1935 | ·14 | ·49 | ·23 | 1·33 | ·36 | ·15 | 6·8 | 37·7 | 4·33 | Bush. |
| | | April, 1935 | ·14 | ·78 | ·23 | 1·93 | ·66 | ·31 | 7·8 | 36·5 | 6·58 | Bush. |
| | | July, 1935 | ·20 | ·84 | ·43 | 1·85 | ·28 | ·39 | 10·5 | 28·2 | 6·19 | Bush. |
| | | Oct., 1935 | ·22 | ·77 | ·30 | 2·19 | 1·00 | ·49 | 9·6 | 29·1 | 7·40 | Bush. |
| Steenrotsfontein.. | Beaufort West. | Nov., 1934 | ·24 | 1·37 | ·40 | 3·24 | 1·96 | 1·58 | 16·5 | 26·0 | 14·04 | Bush. |
| | | Feb., 1935 | ·15 | 1·10 | ·29 | 1·69 | 2·36 | 1·05 | 9·7 | 32·6 | 11·87 | Bush. |
| | | May, 1935 | ·20 | ·99 | ·30 | 1·72 | ·83 | ·61 | 11·5 | 33·5 | 8·68 | Bush. |
| Sunnyside........ | Beaufort West. | Jan., 1935 | ·12 | 1·61 | ·54 | 2·49 | 1·78 | 1·23 | 11·9 | 27·2 | 13·30 | Bush. |
| | | Mar., 1935 | ·12 | 1·27 | ·28 | 1·52 | ·89 | ·73 | 7·4 | 39·6 | 8·42 | Bush. |
| Rhenosterkop.... | Beaufort West. | Jan., 1935 | ·12 | 1·52 | ·35 | 1·64 | 2·43 | 1·77 | 10·4 | 27·0 | 14·60 | Bush. |
| | | April, 1935 | ·16 | 2·10 | ·50 | 1·69 | 1·37 | ·97 | 11·7 | 27·1 | 11·75 | Bush. |
| Celeryfontein..... | Carnarvon..... | Nov., 1934 | ·16 | ·82 | ·38 | 1·09 | 2·53 | 2·40 | 13·2 | 29·5 | 11·95 | Bush. |
| | | Feb., 1935 | ·12 | ·45 | ·12 | 1·15 | ·24 | ·11 | 4·5 | 43·3 | 3·37 | Bush. |
| | | May, 1935 | ·14 | ·88 | ·43 | 1·58 | 1·76 | ·65 | 8·1 | 35·8 | 10·80 | Bush. |
| | | Aug., 1935 | ·32 | ·96 | ·21 | 1·04 | ·38 | ·20 | 8·3 | 41·5 | 5·56 | Bush. |
| Klerefontein...... | Carnarvon..... | Dec., 1934 | ·18 | ·63 | ·16 | 1·67 | ·19 | ·23 | 9·2 | 42·6 | 5·00 | Grass, green, short, and bush; mostly bush. |
| | | Mar., 1935 | ·12 | ·58 | ·22 | ·87 | ·31 | ·21 | 6·2 | 45·7 | 3·93 | Bush. |
| | | June, 1935 | ·12 | ·55 | ·24 | 1·30 | ·26 | ·42 | 5·8 | 39·1 | 3·13 | Grass, short, and bush. |
| | | Sept., 1935 | ·17 | ·79 | ·21 | 1·81 | ·44 | ·28 | 8·0 | 38·2 | 7·08 | Bush. |
| Rhenosterkolk.... | Carnarvon..... | Jan., 1935 | ·17 | ·74 | ·30 | 1·68 | 2·07 | 1·06 | 10·3 | 32·8 | 10·53 | Bush. |
| | | April, 1935 | ·19 | 1·20 | ·53 | 1·93 | 2·44 | 1·61 | 12·9 | 31·8 | 13·82 | Bush. |
| | | July, 1935 | ·23 | ·58 | ·49 | 2·57 | 4·01 | 2·39 | 14·3 | 22·6 | 17·25 | Bush. |
| | | Oct., 1935 | ·15 | ·91 | ·36 | 1·53 | 1·56 | ·73 | 8·1 | 37·4 | 9·58 | Bush. |

## AREA 16 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rooidam (Van Wyksvlei) | Carnarvon..... | June, 1934 | ·14 | ·87 | ·38 | 1·19 | 2·19 | ·42 | 7·5 | 26·9 | 9·75 | Grass, brown, and bush; most bush. |
| | | Sept., 1934 | ·14 | 1·06 | ·38 | 1·65 | 2·68 | 1·83 | 11·8 | 28·5 | 12·70 | Grass, brown, and bush. |
| | | Oct., 1934 | ·10 | 1·00 | ·16 | ·73 | ·50 | ·21 | 5·9 | 42·0 | 4·61 | Bush. |
| | | Jan., 1935 | ·18 | 1·36 | ·48 | 2·05 | 1·94 | 1·59 | 12·8 | 29·2 | 12·32 | Grass, mainly brown, and bush; mostly bush. |
| | | April, 1935 | ·13 | ·78 | ·38 | 1·86 | 1·23 | ·93 | 8·3 | 34·6 | 7·98 | Grass, brown, and bush; mostly bush. |
| | | July, 1935 | ·15 | 1·18 | ·38 | 1·16 | 1·64 | ·76 | 10·2 | 28·1 | 9·84 | Grass, brown, and bush; mostly bush. |
| | | Oct., 1935 | ·12 | 1·52 | ·45 | ·96 | 9·92 | 17·10 | 8·6 | 20·1 | 35·40 | Bush. |
| Skietkloof (Van Wyksvlei) | Carnarvon..... | Nov., 1934 | ·19 | 1·17 | ·25 | 1·62 | ·85 | ·41 | 12·1 | 28·0 | 7·28 | Bush. |
| | | Feb., 1935 | ·12 | ·96 | ·33 | 1·09 | 1·84 | ·89 | 7·4 | 34·9 | 7·68 | Grass, mainly brown, and bush; mostly bush. |
| | | May, 1935 | ·11 | 1·20 | ·51 | ·67 | 7·60 | 5·96 | 8·7 | 21·2 | 30·15 | Bush. |
| | | Aug., 1935 | ·20 | 1·11 | ·37 | 2·86 | 2·52 | 1·00 | 13·7 | 25·8 | 11·94 | Grass, brown, and bush; mostly bush. |
| | | Nov., 1935 | ·067 | 1·54 | ·40 | 1·01 | 2·82 | ·62 | 9·2 | 33·6 | 13·18 | Bush. |
| Danielsdam (Van Wyksvlei) | Carnarvon..... | Dec., 1934 | ·18 | ·82 | ·27 | 2·09 | 2·07 | 1·78 | 10·9 | 34·6 | 10·93 | Grass, green, and bush; mostly bush. |
| | | Mar., 1935 | ·13 | 1·80 | ·18 | 1·63 | ·80 | 1·65 | 7·6 | 40·5 | 8·92 | Grass, mainly brown, and bush; mostly bush. |
| | | Sept., 1935 | ·12 | 1·07 | ·37 | 1·70 | 2·34 | 1·95 | 8·1 | 30·9 | 12·23 | Bush. |
| Blauwkrans...... | Carnarvon..... | Nov., 1934 | ·23 | 1·09 | ·37 | 2·12 | ·68 | ·48 | 11·6 | 29·3 | 7·51 | Bush. |
| | | April, 1935 | ·15 | ·59 | ·26 | 1·74 | ·27 | ·20 | 7·6 | 40·5 | 4·85 | Bush. |
| Oorlogshoek...... | Carnarvon..... | Nov., 1934 | ·13 | ·80 | ·34 | 1·78 | 1·46 | ·99 | 9·4 | 31·4 | 9·32 | Grass, mainly green, and bush. |
| | | Mar., 1935 | ·16 | ·44 | ·28 | 1·39 | ·82 | 1·02 | 6·4 | 42·9 | 5·00 | Grass and bush; mostly bush. |
| Vryleegte........ | Carnarvon..... | Nov., 1934 | ·25 | 1·05 | ·36 | 2·41 | 1·28 | ·79 | 16·0 | 24·5 | 9·06 | Grass, mainly green, and bush; mostly bush. |
| | | Mar., 1935 | ·11 | ·54 | ·13 | ·67 | ·47 | ·13 | 7·2 | 45·9 | 4·10 | Bush. |

## AREA 17.

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biesiesvlei (Nieuwerust) | Van Rhynsdorp | Nov., 1934 | ·094 | 1·69 | ·64 | 1·53 | 2·38 | 3·52 | 7·6 | 30·8 | 14·78 | Bush. |
| | | Jan., 1935 | ·092 | 1·33 | ·60 | 1·37 | 1·57 | 2·60 | 6·4 | 37·4 | 11·16 | Bush. |
| | | April, 1935 | ·12 | 1·05 | ·58 | 1·40 | 2·88 | 2·04 | 7·7 | 34·9 | 13·48 | Bush. |
| | | Aug., 1935 | ·18 | 1·90 | ·64 | 1·98 | 4·09 | 6·40 | 7·9 | 26·0 | 19·80 | Bush. |
| | | Oct., 1935 | ·16 | 1·24 | ·60 | 1·51 | 3·25 | 3·29 | 10·3 | 26·4 | 15·18 | Bush. |
| Middelput (Nieuwerust) | Van Rhynsdorp | Nov., 1934 | ·094 | 1·05 | ·65 | 1·42 | 1·40 | 2·46 | 8·1 | 29·3 | 10·00 | Bush. |
| | | Mar., 1935 | ·10 | 1·05 | ·48 | 1·30 | ·84 | 1·80 | 8·1 | 39·1 | 7·80 | Bush. |
| | | June, 1935 | ·13 | 1·59 | ·51 | 1·75 | 1·32 | 3·05 | 10·9 | 33·5 | 11·24 | Bush. |
| | | Sept., 1935 | ·15 | ·90 | ·70 | 1·86 | 1·65 | 2·82 | 10·4 | 30·1 | 12·06 | Bush. |
| Rooivlei (Nieuwerust) | Van Rhynsdorp | Jan., 1935 | ·06 | ·49 | ·25 | ·70 | ·31 | ·39 | 4·5 | 32·4 | 3·42 | Bush. |
| | | April, 1935 | ·066 | ·73 | ·24 | ·88 | ·49 | ·70 | 5·4 | 34·1 | 5·04 | Bush. |
| | | July, 1935 | ·13 | 1·12 | ·32 | 1·49 | 1·05 | 2·13 | 9·7 | 31·6 | 9·54 | Bush. |
| | | Oct., 1935 | ·10 | 1·17 | ·50 | 1·28 | 1·28 | 1·96 | 7·4 | 31·2 | 9·14 | Bush. |
| Sandkraal........ | Van Rhynsdorp | Nov., 1934 | ·083 | ·75 | ·55 | 1·59 | 3·43 | 5·30 | 9·4 | 26·1 | 14·90 | Bush. |
| | | Feb., 1935 | ·06 | ·25 | ·06 | ·56 | ·12 | ·12 | 4·5 | 42·4 | 2·05 | Bush. |
| | | May, 1935 | ·26 | 2·43 | ·65 | 2·91 | 1·76 | 5·06 | 19·3 | 23·8 | 18·48 | Bush. |
| | | Aug., 1935 | ·17 | ·95 | ·50 | 2·62 | 1·72 | 2·66 | 13·9 | 25·3 | 11·24 | Bush. |
| Baiefontein...... | Van Rhynsdorp | Dec., 1934 | ·072 | ·36 | ·23 | 1·00 | ·58 | ·41 | 7·4 | 34·1 | 4·14 | Bush. |
| | | Mar., 1935 | ·046 | ·13 | ·07 | ·42 | ·06 | ·23 | 3·8 | 39·0 | 1·23 | Grass, brown, and bush. |
| | | June, 1935 | ·12 | ·56 | ·26 | 1·69 | ·65 | 1·11 | 10·6 | 35·2 | 5·60 | Grass, mainly green, and bush. |
| | | Sept., 1935 | ·086 | ·41 | ·15 | 1·20 | ·18 | ·39 | 7·4 | 36·9 | 3·65 | Grass, green, and bush; mostly bush. |
| Diepvlei......... | Van Rhynsdorp | Jan., 1935 | ·073 | ·64 | ·29 | 1·28 | ·81 | ·37 | 7·3 | 41·0 | 6·19 | Bush. |
| | | April, 1935 | ·11 | ·78 | ·46 | 1·39 | ·80 | ·50 | 8·0 | 28·6 | 6·82 | Bush. |
| | | July, 1935 | ·11 | 1·48 | ·23 | 1·70 | 1·81 | 1·22 | 9·3 | 39·1 | 11·45 | Bush. |
| | | Oct., 1935 | ·087 | ·88 | ·42 | 1·05 | 1·71 | ·89 | 8·0 | 44·4 | 8·64 | Bush. |
| Oorlogskloof (Nieuwoudtville) | Calvinia....... | Nov., 1934 | ·13 | 1·17 | ·34 | 1·66 | 1·23 | ·99 | 10·0 | 30·3 | 9·46 | Bush. |
| | | Feb., 1935 | ·057 | ·39 | ·13 | ·66 | ·13 | ·14 | 3·7 | 36·1 | 2·44 | Bush. |
| | | May, 1935 | ·13 | ·52 | ·22 | ·93 | ·19 | ·21 | 7·5 | 41·1 | 3·97 | Bush. |
| | | Aug., 1935 | ·13 | 1·09 | ·27 | 3·16 | ·51 | 1·17 | 12·1 | 24·0 | 8·90 | Bush. |

AREA 17 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grasberg (Nieuwoudtville) | Calvinia....... | Dec., 1934 | ·12 | ·81 | ·32 | ·85 | ·43 | ·59 | 8·2 | 34·5 | 5·54 | Bush. |
| | | Mar., 1935 | ·07 | ·26 | ·10 | ·83 | ·13 | ·40 | 5·2 | 32·9 | 2·04 | Grass and bush. |
| | | June, 1935 | ·14 | 1·08 | ·73 | 1·42 | 2·44 | 1·48 | 10·5 | 26·8 | 11·40 | Bush. |
| | | Sept., 1935 | ·21 | ·92 | ·50 | 1·88 | 1·99 | 1·28 | 10·4 | 29·5 | 10·34 | Bush. |
| Matjesfontein (Nieuwoudtville) | Calvinia....... | Jan., 1935 | ·13 | ·94 | ·38 | 1·47 | 2·04 | 2·25 | 9·1 | 32·6 | 11·44 | Bush. |
| | | April, 1935 | ·074 | 1·32 | ·55 | 1·14 | 4·16 | 2·04 | 8·3 | 28·9 | 16·30 | Bush. |
| | | July, 1935 | ·16 | ·88 | ·50 | 1·32 | 1·76 | 1·14 | 9·1 | 38·0 | 9·68 | Bush. |
| | | Oct., 1935 | ·18 | 1·27 | ·48 | 1·44 | 2·39 | 1·70 | 6·9 | 31·6 | 12·04 | Bush. |
| Diepdrift........ | Calvinia....... | Nov., 1934 | ·097 | ·53 | ·19 | 1·10 | ·87 | ·09 | 7·4 | 36·7 | 5·70 | Bush. |
| | | Feb., 1935 | ·12 | ·97 | ·21 | ·86 | ·36 | ·25 | 5·4 | 42·4 | 4·67 | Bush. |
| | | May, 1935 | ·10 | 1·19 | ·28 | ·84 | ·70 | ·27 | 7·9 | 36·3 | 6·62 | Bush. |
| | | Aug., 1935 | ·14 | ·99 | ·25 | 1·13 | 1·20 | ·53 | 7·2 | 35·1 | 6·81 | Bush. |
| Upper Downs.... | Calvinia....... | Dec., 1934 | ·15 | ·92 | ·33 | 1·88 | 1·99 | 1·37 | 9·2 | 34·0 | 11·24 | Bush. |
| | | Mar., 1935 | ·073 | 1·60 | ·31 | ·76 | ·84 | ·14 | 6·2 | 43·3 | 6·78 | Bush. |
| | | June, 1935 | ·11 | ·88 | ·28 | 1·11 | 1·38 | ·80 | 7·3 | 38·0 | 7·45 | Grass, brown, and bush; mostly bush. |
| | | Sept., 1935 | ·16 | ·71 | ·34 | 1·64 | 1·60 | 1·13 | 8·7 | 34·8 | 8·98 | Bush. |
| Van Rhynshoek.. | Calvinia....... | Jan., 1935 | ·098 | ·68 | ·29 | 1·42 | 1·22 | ·33 | 6·3 | 37·2 | 7·48 | Bush. |
| | | July, 1935 | ·15 | 1·31 | ·33 | 1·49 | ·18 | ·43 | 9·4 | 31·2 | 6·06 | Grass, green, and bush; mostly bush. |
| | | Oct., 1935 | ·22 | 1·12 | ·41 | 2·65 | ·36 | ·65 | 6·3 | 34·1 | 8·66 | Bush. |
| Naroegena (Brandvlei) | Calvinia....... | Nov., 1934 | ·10 | 1·01 | ·20 | — | ·38 | ·28 | 8·1 | 42·1 | 5·98 | Bush. |
| | | Mar., 1935 | ·074 | ·58 | ·11 | ·97 | ·49 | ·17 | 5·2 | — | 4·27 | Bush. |
| | | June, 1935 | ·13 | ·97 | ·28 | 1·40 | 1·64 | ·49 | 7·2 | 38·0 | 9·10 | Bush. |
| | | Sept., 1935 | ·10 | 1·47 | ·28 | ·95 | 1·64 | ·36 | 6·4 | 39·7 | 9·80 | Bush. |
| Verdwaalvlei (Brandvlei) | Calvinia....... | Jan., 1935 | ·07 | 2·95 | ·41 | 1·02 | 1·00 | ·42 | 6·5 | 31·1 | 12·27 | Bush. |
| | | April, 1935 | ·10 | 2·11 | ·38 | 1·52 | ·89 | ·52 | 8·1 | 32·9 | 10·58 | Bush. |
| | | July, 1935 | ·14 | 1·06 | ·22 | 1·33 | ·60 | ·44 | 7·8 | 36·3 | 6·00 | Grass, brown, short, and bush; mostly bush. |
| | | Oct., 1935 | ·11 | 1·55 | ·27 | 1·02 | ·81 | 1·18 | 5·7 | 39·7 | 8·26 | Bush. |

## AREA 17 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Karelsekolk (Brandvlei) | Calvinia....... | Feb., 1935 | ·11 | ·66 | ·15 | ·83 | ·86 | ·12 | 4·8 | 45·3 | 5·34 | Bush. |
| | | Aug., 1935 | ·095 | 1·99 | ·74 | 1·71 | ·71 | ·67 | 6·1 | 30·1 | 10·80 | Bush. |
| Lospersplaas (Loeriesfontein) | Calvinia....... | Nov., 1934 | ·057 | 1·17 | ·26 | ·72 | 1·35 | ·59 | 6·4 | 36·2 | 7·35 | Grass, brown, and bush; mostly bush. |
| | | May, 1935 | ·083 | 1·00 | ·14 | ·61 | ·38 | ·16 | 4·8 | 43·3 | 4·44 | Grass, brown, and bush. |
| Kaffersbank (Loeriesfontein) | Calvinia....... | Dec., 1934 | ·11 | 1·09 | ·40 | 1·89 | 3·05 | 1·97 | 7·2 | 35·3 | 15·07 | Bush. |
| | | Mar., 1935 | ·12 | ·91 | ·26 | 1·16 | 4·42 | 1·58 | 7·9 | 34·5 | 16·10 | Bush. |
| | | June, 1935 | ·11 | ·73 | ·36 | ·83 | 1·03 | ·66 | 8·7 | 43·8 | 6·24 | Bush. |
| Krantzgat River (Loeriesfontein) | Calvinia....... | Jan., 1935 | ·11 | 1·11 | ·47 | 1·39 | 1·21 | ·69 | 6·6 | 36·1 | 8·27 | Bush. |
| | | April, 1935 | ·14 | ·83 | ·36 | ·84 | 3·10 | 1·45 | 9·4 | 34·5 | 12·10 | Bush. |
| Koets (Kamieskroon) | Namaqualand.. | Nov., 1934 | ·086 | ·84 | ·25 | ·98 | ·17 | ·33 | 8·5 | 29·2 | 4·50 | Bush. |
| | | Feb., 1935 | ·098 | 1·08 | ·24 | 1·29 | ·25 | ·39 | 6·9 | 25·5 | 5·90 | Bush. |
| | | May, 1935 | ·14 | ·84 | ·35 | 1·20 | ·27 | ·72 | 12·6 | 36·5 | 5·08 | Bush. |
| | | Sept., 1935 | ·16 | 1·29 | ·43 | 1·82 | ·81 | 1·66 | 8·9 | 35·3 | 9·04 | Grass, green, and bush; mostly bush. |
| Olienfontein (Kamieskroon) | Namaqualand.. | Dec., 1934 | ·077 | 1·08 | ·19 | 1·30 | ·21 | ·44 | 6·4 | 37·6 | 5·98 | Bush. |
| | | Mar., 1935 | ·053 | ·82 | ·14 | ·42 | ·05 | ·12 | 4·5 | 38·8 | 2·20 | Bush. |
| | | June, 1935 | ·094 | ·83 | ·38 | 1·39 | ·09 | ·33 | 8·6 | 26·1 | 5·17 | Bush. |
| | | Oct., 1935 | ·33 | 1·59 | ·32 | 3·17 | ·44 | 1·44 | 14·0 | 27·0 | 11·05 | Bush. |
| Grootvlei (Kamieskroon) | Namaqualand.. | Jan., 1935 | ·05 | ·37 | ·14 | ·67 | ·18 | ·22 | 4·7 | 51·8 | 2·87 | Bush. |
| | | April, 1935 | ·05 | ·34 | ·16 | ·41 | ·11 | ·08 | 5·1 | 49·0 | 2·19 | Bush. |
| Morgenskadu (Springbok) | Namaqualand.. | Nov., 1934 | ·083 | ·33 | ·18 | 1·02 | ·81 | ·60 | 6·2 | 34·5 | 4·02 | Grass, brown, and bush. |
| | | Feb., 1935 | ·21 | ·72 | ·29 | 2·07 | ·56 | ·58 | 11·4 | 37·1 | 6·00 | Grass and bush; mostly grass. |
| | | May, 1935 | ·13 | ·55 | ·25 | ·89 | ·70 | ·37 | 7·1 | 39·6 | 4·32 | Grass and bush. |
| | | Aug., 1935 | ·18 | ·94 | ·47 | 2·08 | 1·91 | 2·00 | 9·1 | 28·2 | 9·90 | Bush. |
| | | Nov., 1935 | ·11 | ·68 | ·32 | 1·37 | 1·32 | 1·09 | 5·9 | 34·1 | 7·54 | Bush. |
| Goobees (Springbok) | Namaqualand.. | Dec., 1934 | ·084 | ·43 | ·13 | 1·00 | ·49 | ·38 | 4·8 | 38·7 | 3·43 | Grass, brown, and bush. |
| | | Mar., 1935 | ·09 | ·86 | ·29 | ·85 | ·66 | ·20 | 6·2 | 34·8 | 5·04 | Bush. |
| | | Jun., 1935 | ·20 | 1·07 | ·50 | 2·12 | 2·34 | 1·87 | 13·1 | 21·7 | 11·86 | Bush. |
| | | Sept., 1935 | ·20 | 1·33 | ·44 | 2·86 | 1·78 | 1·67 | 10·6 | 29·8 | 14·48 | Bush. |

## AREA 17 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Orangefontein (Springbok) | Namaqualand.. | Jan., 1935 | ·087 | ·74 | ·42 | ·76 | ·98 | ·56 | 5·6 | 30·8 | 6·56 | Bush. |
| | | Oct., 1935 | ·13 | ·97 | ·57 | 1·55 | 1·25 | 1·09 | 6·7 | 30·6 | 8·30 | Bush. |
| Bloedsmaak (Garies) | Namaqualand.. | Nov., 1934 | ·12 | ·74 | ·27 | 1·80 | ·64 | 1·30 | 8·4 | 34·8 | 6·18 | Grass, brown, and bush. |
| | | Feb., 1935 | ·11 | ·59 | ·22 | ·94 | ·34 | ·36 | 6·2 | 37·7 | 4·04 | Grass, mainly brown, and bush; mostly bush. |
| | | May, 1935 | ·086 | ·63 | ·17 | ·92 | ·25 | ·38 | 6·7 | 41·3 | 3·80 | Bush. |
| | | Aug., 1935 | ·12 | ·76 | ·40 | 1·64 | 1·01 | 1·29 | 8·8 | 40·8 | 7·14 | Bush. |
| Kliphoek (Garies) | Namaqualand.. | Dec., 1934 | ·15 | 1·15 | ·45 | 2·21 | 3·85 | 5·14 | 10·0 | 28·4 | 16·78 | Bush. |
| | | Mar. 1935 | ·17 | ·68 | ·27 | 1·46 | 1·55 | 1·86 | 6·7 | 40·6 | 8·12 | Grass, mainly brown, and bush; mostly bush. |
| | | June, 1935 | ·19 | 1·11 | ·58 | 1·82 | 2·54 | 3·53 | 12·0 | 29·3 | 15·27 | Bush. |
| | | Sept., 1935 | ·13 | ·91 | ·61 | 1·60 | 2·67 | 3·70 | 8·4 | 39·7 | 13·90 | Bush. |
| Rooiheuwel (Garies) | Namaqualand.. | Jan., 1935 | ·11 | 1·03 | ·25 | 1·64 | 1·22 | 1·90 | 7·3 | 34·4 | 9·48 | Bush. |
| | | April, 1935 | ·11 | ·76 | ·41 | 1·38 | ·97 | ·93 | 6·2 | 42·8 | 6·16 | Bush. |
| | | July, 1935 | ·11 | ·92 | ·38 | 1·69 | 1·02 | 1·49 | 9·3 | 36·5 | 8·24 | Bush. |
| | | Oct., 1935 | ·10 | ·77 | ·40 | 1·18 | ·83 | ·98 | 6·2 | 39·8 | 6·33 | Bush. |
| Swartfontein (Wallekraal) | Namaqualand.. | Nov., 1934 | ·11 | 1·39 | ·36 | 1·08 | ·99 | 1·91 | 5·6 | 36·8 | 9·08 | Bush. |
| | | Feb., 1935 | ·086 | ·58 | ·23 | ·75 | ·36 | ·42 | 5·0 | 48·2 | 3·82 | Bush. |
| | | May, 1935 | ·11 | 1·14 | ·41 | 1·54 | ·79 | ·18 | 7·7 | 36·4 | 8·75 | Bush. |
| | | Aug., 1935 | ·18 | 1·38 | ·53 | 2·36 | 2·41 | 2·86 | 11·6 | 29·1 | 13·77 | Bush. |
| Avontuur (Wallekraal) | Namaqualand.. | Nov., 1934 | ·13 | 1·85 | ·51 | 1·80 | 1·49 | 2·10 | 9·7 | 31·9 | 13·10 | Bush. |
| | | Mar., 1935 | ·12 | ·97 | ·29 | 1·32 | 1·46 | 1·69 | 6·1 | 35·9 | 9·14 | Bush. |
| | | June, 1935 | ·18 | 1·25 | ·55 | 2·03 | 1·75 | 2·50 | 11·8 | 37·6 | 11·82 | Bush. |
| | | Sept., 1935 | ·17 | 1·83 | ·73 | 1·87 | 3·47 | 4·48 | 10·7 | 27·0 | 19·30 | Bush. |
| Weltevreden (Wallekraal) | Namaqualand.. | Dec., 1934 | ·097 | ·71 | ·48 | 1·17 | 1·36 | 2·07 | 6·5 | 39·9 | 8·80 | Bush. |
| | | April, 1935 | ·11 | 1·42 | ·73 | 1·71 | 3·29 | 3·94 | 5·9 | 21·6 | 15·80 | Bush. |
| | | July, 1935 | ·15 | 1·13 | ·56 | 1·79 | 2·23 | 3·67 | 11·7 | 33·2 | 13·45 | Bush. |
| | | Oct., 1935 | ·11 | ·77 | ·58 | 1·66 | 2·04 | 2·64 | 6·7 | 35·9 | 11·50 | Bush. |

## AREA 18.

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vrouenspan...... | Gordonia...... | Nov., 1934 | ·062 | ·70 | ·20 | ·65 | ·89 | ·50 | 4·7 | 37·4 | 4·44 | Grass, brown, and bush. |
| | | Feb., 1935 | ·12 | 1·04 | ·25 | 1·53 | ·43 | ·56 | 8·4 | 35·4 | 5·88 | Grass, mainly green, and bush. |
| | | May, 1935 | ·12 | ·91 | ·19 | 1·22 | 1·50 | ·08 | 8·3 | 34·1 | 8·28 | Grass, mainly brown, leafy, and bush. |
| | | Sept., 1935 | ·13 | ·69 | ·26 | 1·45 | 1·46 | 1·14 | 8·9 | 32·0 | 7·22 | Grass, mainly brown, and bush. |
| Springbokvlei.... | Gordonia...... | Dec., 1934 | ·15 | ·80 | ·27 | 2·58 | ·04 | ·40 | 10·5 | 37·5 | 6·34 | Grass, mainly brown, and bush; mostly bush. |
| | | April, 1935 | ·12 | 1·28 | ·26 | 1·02 | ·05 | ·18 | 8·8 | 38·4 | 4·98 | Grass, brown, and bush; mostly bush. |
| | | Aug., 1935 | ·078 | ·43 | ·08 | ·55 | ·03 | ·13 | 5·9 | 44·6 | 1·98 | Grass, brown, long. |
| | | Oct., 1935 | ·12 | ·51 | ·18 | 1·87 | ·83 | ·53 | 7·6 | 39·3 | 5·94 | Grass, mainly brown, and bush; mostly grass. |
| Langklip......... | Gordonia...... | Jan., 1935 | ·094 | 2·03 | ·27 | 1·57 | ·22 | ·53 | 6·6 | 40·1 | 8·02 | Grass, mainly green, and bush. |
| | | Mar., 1935 | ·085 | 1·37 | ·25 | 1·16 | ·08 | ·17 | 5·6 | 42·9 | 5·37 | Grass, brown, and bush. |
| | | July, 1935 | ·11 | 1·24 | ·21 | ·98 | ·03 | ·18 | 5·4 | 42·6 | 5·00 | Grass, brown, and bush. |
| Boksputs (Keimoes) | Kenhardt...... | Nov., 1934 | ·062 | ·51 | ·14 | ·49 | ·02 | ·11 | 4·1 | 40·0 | 2·33 | Grass, brown. |
| | | Feb., 1935 | ·13 | 1·79 | ·36 | 1·44 | ·23 | ·34 | 6·2 | 34·9 | 7·78 | Grass, mainly brown, and bush. |
| | | June, 1935 | ·11 | ·62 | ·13 | ·78 | ·11 | ·16 | 5·7 | 42·4 | 2·93 | Grass, mainly brown, and bush; mostly grass. |
| | | Sept., 1935 | ·12 | 2·14 | ·21 | 1·58 | ·32 | ·43 | 7·3 | 36·4 | 8·30 | Grass, brown, and bush. |
| Drogehout (Upington) | Kenhardt...... | Dec., 1934 | ·12 | 1·40 | ·27 | 1·28 | ·03 | ·29 | 7·9 | 35·9 | 5·54 | Grass, mainly green, and bush; mostly grass. |
| | | Mar., 1935 | ·14 | 2·41 | ·37 | 1·48 | ·07 | ·36 | 7·4 | 42·5 | 9·75 | Grass, mainly green, and bush. |
| | | May, 1935 | ·14 | ·52 | ·13 | 1·20 | ·06 | ·20 | 9·1 | 36·2 | 3·25 | Grass. |
| | | Aug., 1935 | ·19 | 1·41 | ·25 | 2·03 | ·33 | ·81 | 8·8 | 30·3 | 7·02 | Grass, brown, and bush. |
| C'Nyaas Oost (Upington) | Kenhardt...... | Jan., 1935 | ·093 | ·75 | ·17 | 1·12 | ·11 | ·32 | 6·1 | 40·3 | 4·18 | Grass and bush; mostly grass. |
| | | April, 1935 | ·074 | ·49 | ·16 | ·86 | ·74 | ·22 | 5·1 | 35·3 | 3·62 | Grass, brown, and bush; mostly grass. |
| | | July, 1935 | ·11 | ·59 | ·10 | 1·01 | ·26 | ·26 | 5·6 | 37·6 | 3·37 | Grass, mainly brown, and bush; mostly grass. |
| | | Oct., 1935 | ·12 | ·40 | ·14 | ·87 | ·37 | ·20 | 4·0 | 35·5 | 3·13 | Grass, brown, and bush; mostly grass. |
| Koegrabie (Putsonderwater) | Kenhardt...... | Nov., 1934 | ·11 | ·98 | ·29 | 1·55 | trace | ·32 | 10·4 | 34·7 | 5·18 | Grass, green, and bush. |
| | | May, 1935 | ·14 | ·69 | ·17 | 1·46 | ·06 | ·44 | 11·1 | 36·8 | 4·00 | Grass, mainly green, and bush; mostly grass. |
| Olivenhoutdrift... | Kenhardt...... | Dec., 1934 | ·15 | 2·58 | ·43 | 1·44 | ·06 | ·37 | 11·2 | 30·5 | 10·07 | Bush. |
| | | Mar., 1935 | ·10 | 1·21 | ·30 | 2·70 | ·11 | ·36 | 14·2 | 29·0 | 7·72 | Grass, green, and bush. |
| | | Sept., 1935 | ·21 | 1·06 | ·26 | 2·52 | ·13 | ·89 | 10·4 | 25·7 | 7·70 | Grass, green, and bush; mostly bush. |

AREA 18 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Eselfontein (Upington)** | Kenhardt...... | Jan., 1935 | ·13 | ·35 | ·33 | 1·25 | ·08 | 38 | 5·6 | 41·1 | 4·97 | Grass, mainly brown, and bush; mostly grass. |
| | | April, 1935 | ·12 | 2·48 | ·30 | 1·38 | ·32 | 1·51 | 10·0 | 31·5 | 9·52 | Grass and bush. |
| | | July, 1935 | ·14 | 1·16 | ·26 | 1·90 | ·06 | ·54 | 9·4 | 31·0 | 6·16 | Grass and bush; mostly grass. |
| **Demansput**...... | Kenhardt...... | Nov., 1934 | ·12 | ·62 | ·38 | 1·24 | 4·31 | 1·19 | 8·6 | 27·6 | 16·05 | Bush. |
| | | Feb., 1935 | ·14 | 1·65 | ·37 | 1·50 | 5·98 | 3·95 | 10·2 | 24·5 | 24·00 | Bush. |
| | | May, 1935 | ·16 | 1·04 | ·50 | 2·03 | 2·50 | ·09 | 8·1 | 31·2 | 13·25 | Bush. |
| | | Aug., 1935 | ·15 | 1·28 | ·68 | 1·82 | 4·70 | 2·01 | 5·3 | 27·7 | 18·75 | Bush. |
| **Rooiberg**......... | Kenhardt...... | Dec., 1934 | ·20 | 1·10 | ·29 | 1·90 | ·96 | ·76 | 15·7 | 31·7 | 9·07 | Grass, mainly green, short, and bush; mostly grass. |
| | | Mar., 1935 | ·12 | 1·22 | ·33 | 1·33 | 1·81 | ·50 | 9·0 | 36·3 | 10·40 | Grass, brown, and bush: mostly bush. |
| | | June, 1935 | ·13 | 1·21 | ·45 | 1·65 | 1·53 | ·65 | 10·2 | 29·0 | 9·44 | Grass, brown, and bush. |
| | | Sept., 1935 | ·11 | 1·03 | ·37 | 1·32 | 1·71 | 1·28 | 8·5 | 35·8 | 8·80 | Grass, mainly brown, and bush. |
| **Middelpos**........ | Kenhardt...... | Jan., 1935 | ·084 | 1·19 | ·31 | 1·46 | 1·53 | ·70 | 9·4 | 33·8 | 9·40 | Grass, brown, short, and bush; mostly bush. |
| | | April, 1935 | ·16 | ·91 | ·36 | 2·43 | 1·12 | ·82 | 11·2 | 31·0 | 8·76 | Grass and bush. |
| | | July, 1935 | ·13 | 1·31 | ·45 | 1·42 | 1·27 | ·58 | 10·8 | 31·9 | 10·00 | Grass and bush; mostly bush. |
| | | Oct., 1935 | ·13 | 1·39 | ·35 | 2·04 | 3·74 | 2·14 | 8·2 | 27·9 | 16·38 | Bush. |
| **Leeuwkop**........ | Kenhardt...... | Nov., 1934 | ·075 | ·38 | ·16 | ·80 | 1·20 | ·92 | 8·6 | 37·6 | 5·16 | Grass, brown, and bush. |
| | | Feb., 1935 | ·12 | 1·27 | ·45 | 1·43 | ·62 | ·39 | 6·4 | 34·8 | 6·60 | Grass, brown, and bush. |
| | | May, 1935 | ·077 | 1·48 | ·27 | ·89 | ·47 | ·24 | 6·2 | 38·9 | 6·30 | Grass, brown, and bush. |
| | | Aug., 1935 | ·088 | ·97 | ·27 | ·84 | 1·35 | ·35 | 5·2 | 39·5 | 5·63 | Grass, brown, and bush; mostly grass. |
| **Driekop Noord**... | Kenhardt...... | Dec., 1934 | ·15 | ·63 | ·18 | 1·22 | ·35 | ·35 | 7·3 | 35·6 | 3·92 | Grass, mainly green, and bush. |
| | | Mar., 1935 | ·12 | 2·40 | ·46 | ·83 | ·20 | ·41 | 7·0 | 38·7 | 8·24 | Grass and bush. |
| | | June, 1935 | ·13 | 1·04 | ·34 | 1·11 | ·03 | ·20 | 6·5 | 39·2 | 4·83 | Grass, mainly brown, and bush. |
| | | Sept., 1935 | ·10 | ·85 | ·24 | ·96 | 1·31 | ·19 | 6·8 | 36·8 | 6·38 | Grass, brown, and bush; mostly grass. |
| **Olienhoutkolk**.... | Kenhardt...... | Jan., 1935 | ·027 | ·36 | ·05 | ·15 | ·03 | ·48 | 2·8 | 40·0 | 1·33 | Grass, brown. |
| | | April, 1935 | ·053 | ·38 | ·06 | ·50 | ·09 | ·06 | 3·8 | 42·6 | 2·03 | Grass, brown, and bush. |
| | | July, 1935 | ·10 | ·99 | ·18 | ·96 | ·30 | ·19 | 6·3 | 41·8 | 4·64 | Grass, mainly brown, and bush. |
| | | Oct., 1935 | ·11 | 1·11 | ·22 | ·83 | ·68 | ·32 | 6·5 | 40·3 | 5·50 | Grass, brown, short, and bush. |
| **Vrede (Upington)**. | Kenhardt...... | Nov., 1934 | ·087 | 2·19 | ·32 | ·74 | ·04 | ·12 | 7·7 | 39·8 | 7·62 | Bush. |
| | | Feb., 1935 | ·10 | ·62 | ·29 | ·85 | trace | ·16 | 5·9 | 42·2 | 4·93 | Grass, mainly green, and bush. |
| | | June, 1935 | ·09 | 1·23 | ·55 | 1·54 | trace | ·41 | 8·7 | 37·0 | 6·16 | Grass, mainly brown, and bush; mostly grass. |
| | | Aug., 1935 | ·097 | ·81 | ·33 | 1·52 | ·05 | ·18 | 10·1 | 35·2 | 5·06 | Bush. |

## AREA 18 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Christiana (Upington) | Kenhardt...... | Dec., 1934 | ·11 | ·92 | ·55 | 1·01 | ·88 | ·47 | 12·3 | 33·4 | 6·44 | Grass and bush. |
| | | Mar., 1935 | ·13 | ·29 | ·12 | ·89 | trace | ·11 | 9·4 | 38·2 | 2·83 | Grass, mainly green, and bush; mostly grass. |
| | | May, 1935 | ·14 | ·73 | ·23 | ·98 | ·88 | ·53 | 10·3 | 31·4 | 4·93 | Grass, mainly green, and bush mostly grass. |
| | | Sept., 1935 | ·12 | 1·02 | ·42 | 1·53 | ·76 | ·36 | 10·5 | 32·8 | 6·44 | Grass and bush. |
| Kalkpoort (Upington) | Kenhardt...... | Jan., 1935 | ·10 | ·51 | ·20 | 1·32 | ·03 | ·37 | 6·8 | 38·3 | 3·59 | Grass, mainly green, and bush; mostly grass. |
| | | April, 1935 | ·066 | 1·12 | ·14 | ·74 | ·08 | ·12 | 6·0 | 38·6 | 3·99 | Grass and bush; mostly grass. |
| | | July, 1935 | ·097 | ·85 | ·36 | 1·27 | ·02 | ·31 | 7·3 | 39·1 | 4·71 | Grass, mainly brown, and bush; mostly grass. |
| | | Oct., 1935 | ·13 | 1·39 | ·29 | 2·59 | ·11 | ·68 | 9·4 | 28·1 | 8·90 | Bush. |
| Swartputs........ | Kenhardt...... | Nov., 1934 | ·077 | ·70 | ·15 | 1·03 | ·18 | ·19 | 6·0 | 41·0 | 3·84 | Grass, brown, and bush. |
| | | Feb., 1935 | ·092 | 1·02 | ·29 | 1·23 | ·46 | ·23 | 5·1 | 38·1 | 5·46 | Grass, brown, and bush. |
| | | May, 1935 | ·11 | ·65 | ·20 | ·83 | ·60 | ·20 | 6·5 | 40·0 | 4·00 | Grass, mainly brown, and bush. |
| De Bakke....... | Kenhardt...... | Dec., 1934 | ·11 | ·67 | ·21 | 1·19 | ·78 | ·50 | 7·9 | 36·3 | 5·00 | Grass and bush. |
| | | Mar., 1935 | ·10 | 1·07 | ·20 | ·75 | ·56 | ·33 | 5·3 | 41·8 | 4·83 | Grass, mainly brown, and bush. |
| | | June, 1935 | ·11 | ·76 | ·13 | 1·14 | ·07 | ·15 | 5·8 | 40·6 | 3·94 | Grass, mainly brown, and bush; mostly grass. |
| Jachtdrift ....... | Kenhardt...... | Jan., 1935 | ·27 | 1·13 | ·31 | 2·31 | ·80 | ·91 | 8·4 | 35·4 | 7·28 | Grass, mainly green, and bush. |
| | | April, 1935 | ·13 | ·76 | ·24 | 1·21 | ·90 | ·30 | 6·7 | 36·0 | 5·41 | Grass, mainly brown, and bush. |
| | | July, 1935 | ·14 | ·63 | ·30 | 1·10 | 1·82 | ·07 | 7·8 | 38·2 | 7·80 | Grass, brown, and bush; mostly bush. |
| Noreseep (Omseep Kans) | Kenhardt...... | Nov., 1934 | ·068 | 1·67 | ·23 | ·83 | ·04 | ·16 | 5·7 | 36·4 | 5·82 | Grass, mainly brown, and bush. |
| | | Feb., 1935 | ·12 | ·77 | ·13 | 1·20 | ·03 | ·06 | 5·0 | 37·8 | 3·95 | Grass, mainly brown. |
| | | May, 1935 | ·15 | 1·52 | ·23 | 1·22 | ·04 | ·21 | 8·3 | 39·8 | 6·36 | Grass and bush. |
| | | Aug., 1935 | ·11 | 1·08 | ·22 | ·90 | ·05 | ·30 | 5·1 | 39·0 | 4·27 | Grass, brown, and bush; mostly grass. |
| Obiep (Namies) .. | Kenhardt...... | Dec., 1934 | ·08 | ·30 | ·08 | ·75 | ·04 | ·18 | 5·3 | 41·2 | 1·93 | Grass, mainly brown. |
| | | Mar., 1935 | ·076 | 1·38 | ·43 | 1·52 | 3·08 | 1·47 | 7·9 | 26·3 | 16·35 | Bush. |
| | | June, 1935 | ·07 | ·33 | ·18 | ·68 | trace | ·13 | 6·0 | 27·9 | 2·19 | Grass, mainly brown. |
| | | Sept., 1935 | ·12 | ·52 | ·16 | 1·34 | 1·09 | ·87 | 7·5 | 35·2 | 4·34 | Grass, mainly brown, and bush; mostly grass. |

AREA 18 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Samoep (Pofadder) | Kenhardt...... | Jan., 1935 | ·14 | ·57 | ·14 | 1·22 | ·34 | ·35 | 5·9 | 41·6 | 3·75 | Grass, mainly brown, and bush; mostly grass. |
| | | April, 1935 | ·15 | 1·25 | ·47 | 1·96 | 3·04 | 1·99 | 10·5 | 27·5 | 14·28 | Grass, brown, and bush. |
| | | July, 1935 | ·14 | 1·84 | ·34 | ·92 | ·61 | ·64 | 9·0 | 35·4 | 8·70 | Bush. |
| | | Oct., 1935 | ·11 | 1·12 | ·48 | 1·69 | 2·14 | 1·39 | 8·4 | 32·2 | 11·92 | Bush. |
| Springputs (Pella) | Kenhardt...... | Oct., 1934 | ·06 | ·95 | ·32 | 1·08 | ·08 | ·32 | 5·9 | 37·2 | 4·31 | Grass, brown, and bush. |
| | | Feb., 1935 | ·11 | 1·38 | ·23 | 1·35 | ·05 | ·21 | 7·2 | 35·7 | 5·84 | Grass, mainly brown, and bush; mostly grass. |
| | | May, 1935 | ·19 | 1·16 | ·23 | 1·65 | ·35 | ·38 | 12·0 | 36·6 | 6·20 | Grass, mainly green, short, and bush. |
| | | Aug., 1935 | ·15 | 1·43 | ·25 | 1·98 | ·12 | ·53 | 9·8 | 31·9 | 7·52 | Bush. |
| Dabipoort (Pella). | Kenhardt...... | Dec., 1934 | ·09 | ·59 | ·13 | 1·02 | ·31 | ·17 | 6·0 | 43·5 | 3·49 | Grass, mainly brown, and bush. |
| | | Mar., 1935 | ·073 | ·75 | ·32 | 1·10 | 1·23 | ·20 | 5·9 | 39·5 | 7·26 | Grass, brown, short, and bush; mostly grass. |
| | | June, 1935 | ·16 | 1·02 | ·70 | 2·03 | 1·94 | 1·15 | 9·6 | 27·6 | 11·48 | Bush. |
| | | Sept., 1935 | ·19 | 1·23 | ·70 | 2·42 | 1·97 | 1·03 | 8·4 | 26·0 | 15·20 | Bush. |
| Gabaib (Namies). | Kenhardt...... | Jan., 1935 | ·11 | ·60 | ·30 | 1·54 | ·60 | ·40 | 9·1 | 37·7 | 4·99 | Grass, mainly green, and bush. |
| | | April, 1935 | ·095 | 1·20 | ·36 | 1·06 | 1·12 | ·69 | 7·0 | 32·6 | 7·50 | Grass, mainly brown, short, and bush: mostly bush. |
| | | July, 1935 | ·15 | ·93 | ·37 | 1·90 | ·14 | ·44 | 11·2 | 31·0 | 6·06 | Bush. |
| | | Oct., 1935 | ·12 | 1·09 | ·35 | 1·50 | 1·60 | 1·15 | 7·0 | 29·5 | 8·68 | Grass, brown, short, and bush. |
| Dabeep (Gamoep) | Namaqualand.. | Nov., 1934 | ·056 | ·50 | ·25 | 1·05 | 1·14 | ·63 | 5·6 | 36·6 | 5·32 | Grass, brown, and bush. |
| | | Feb., 1935 | ·078 | ·76 | ·13 | ·68 | ·78 | ·39 | 4·1 | 37·3 | 4·32 | Grass, brown, and bush. |
| | | May, 1935 | ·075 | ·31 | ·08 | ·42 | ·13 | ·13 | 4·2 | 38·0 | 1·89 | Grass, mainly brown. |
| | | Aug., 1935 | ·22 | 1·03 | ·39 | 2·28 | ·95 | 1·57 | 11·1 | 26·0 | 8·57 | Bush. |
| Lekkerdrink (Gamoep) | Namaqualand.. | Dec., 1934 | ·064 | ·61 | ·26 | 1·15 | ·75 | ·55 | 6·9 | 32·8 | 4·48 | Grass, brown, and bush; mostly grass. |
| | | Mar., 1935 | ·088 | ·68 | ·30 | 1·33 | 1·34 | ·45 | 7·1 | 38·0 | 7·36 | Bush. |
| | | June, 1935 | ·15 | 1·02 | ·34 | 1·28 | 1·11 | ·98 | 10·8 | 35·9 | 8·12 | Bush. |
| | | Sept., 1935 | ·15 | ·72 | ·32 | 1·81 | 1·76 | 1·28 | 9·1 | 31·3 | 9·58 | Grass, brown, and bush. |
| Wolfkraal (Gamoep) | Namaqualand.. | Jan., 1935 | ·086 | ·84 | ·40 | ·98 | 2·36 | 1·55 | 6·3 | 32·6 | 11·55 | Grass, mainly brown, and bush; mostly bush. |
| | | April, 1935 | ·11 | ·66 | ·24 | ·87 | 1·52 | ·43 | 6·1 | 35·2 | 6·40 | Grass and bush; mostly bush. |
| | | July, 1935 | ·16 | ·76 | ·43 | 1·63 | 1·07 | 1·18 | 8·9 | 30·6 | 7·55 | Grass and bush. |
| | | Oct., 1935 | ·11 | ·82 | ·29 | 1·88 | 1·42 | ·86 | 6·3 | 34·7 | 8·62 | Bush. |

AREA 18 (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nakanas (Port Nolloth) | Namaqualand.. | Nov., 1934 | ·10 | 1·80 | ·53 | 1·52 | 1·50 | 2·58 | 7·3 | 32·3 | 11·46 | Bush. |
| | | Feb., 1935 | ·11 | ·90 | ·43 | 1·69 | 3·82 | 1·89 | 6·2 | 31·2 | 14·80 | Bush. |
| | | May, 1935 | ·16 | 1·21 | ·60 | 1·85 | 1·80 | 3·18 | 7·5 | 32·4 | 12·40 | Bush. |
| | | Aug., 1935 | ·24 | 1·80 | ·60 | 2·98 | 2·60 | 4·19 | 14·0 | 25·1 | 15·73 | Bush. |
| | | Nov., 1935 | ·11 | 1·98 | ·67 | 1·65 | 2·97 | 5·22 | 6·8 | 31·6 | 18·36 | Bush. |
| Erdvark (Springbok) | Namaqualand.. | Dec., 1934 | ·093 | 1·14 | ·40 | 1·06 | 1·52 | ·97 | 6·5 | 31·2 | 9·64 | Bush. |
| | | Mar., 1935 | ·16 | 1·12 | ·54 | 1·81 | 4·02 | 3·45 | 7·3 | 29·1 | 18·65 | Bush. |
| | | June, 1935 | ·14 | 1·19 | ·62 | 1·80 | 2·06 | 2·15 | 9·5 | 24·6 | 12·00 | Bush. |
| | | Sept., 1935 | ·17 | 1·84 | ·48 | 2·81 | 2·95 | 2·78 | 11·0 | 25·8 | 18·90 | Bush. |
| Vaalheuwel (Springbok) | Namaqualand.. | Jan., 1935 | ·15 | 1·15 | ·35 | 2·26 | 3·28 | 5·80 | 8·8 | 36·1 | 17·65 | Bush. |
| | | April, 1935 | ·14 | 1·22 | ·71 | 2·06 | 3·21 | 3·49 | 8·3 | 26·0 | 17·30 | Bush. |
| | | July, 1935 | ·12 | 1·78 | ·57 | 1·54 | 2·68 | 3·67 | 8·7 | 30·2 | 16·67 | Bush. |
| | | Oct., 1935 | ·15 | 1·82 | ·56 | 1·84 | 2·65 | 4·12 | 8·5 | 31·0 | 16·60 | Bush. |

### AREA O.

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| The Buries....... | Humansdorp... | Oct., 1933 | ·098 | ·57 | ·20 | 1·48 | ·86 | 1·40 | 7·9 | 27·4 | 6·39 | Grass, green, short, and bush. |
| | | Jan., 1934 | ·092 | ·35 | ·15 | 1·38 | ·23 | ·60 | 7·8 | 33·2 | 3·96 | Grass, mainly green, leafy, and bush. |
| | | May, 1934 | ·034 | ·40 | ·12 | ·72 | ·09 | ·21 | 5·1 | 34·3 | 2·65 | Grass, short, and bush. |
| | | Aug., 1934 | ·06 | ·57 | — | ·75 | ·21 | ·28 | 6·1 | 30·4 | 3·48 | Grass, leafy, and bush. |
| | | Nov., 1934 | ·07 | ·41 | ·17 | 1·32 | ·22 | ·37 | 8·0 | 34·8 | 3·63 | Grass, short, and bush. |
| | | Jan., 1935 | — | ·46 | ·19 | ·82 | ·26 | — | 6·1 | 35·0 | 3·01 | Grass, green, and bush. |
| | | April, 1935 | ·084 | ·73 | ·23 | ·70 | ·43 | ·39 | 6·2 | 33·2 | 4·09 | Grass, mainly green, and bush. |
| | | July, 1935 | ·11 | ·65 | ·24 | ·97 | ·23 | ·37 | 9·0 | 32·2 | 3·70 | Grass, mainly green, leafy, and bush, mostly bush. |
| | | Oct., 1935 | ·078 | ·75 | ·22 | 1·01 | ·20 | ·33 | 6·8 | 30·4 | 3·95 | Grass, green, leafy, and bush. |
| Fairview......... | Humansdorp... | Nov., 1933 | ·10 | ·34 | ·14 | 1·41 | ·29 | ·80 | 13·7 | 35·0 | 4·30 | Grass, mainly green, and bush; mostly grass. |
| | | Feb., 1934 | ·056 | ·43 | ·15 | ·74 | ·27 | ·36 | 5·6 | 30·5 | 2·88 | Grass, mainly green, and bush. |
| | | June 1934 | ·07 | ·65 | ·24 | ·66 | ·56 | ·79 | 9·1 | 29·8 | 4·80 | Grass, mainly brown, short and, bush. |
| | | Sept., 1934 | ·087 | ·63 | ·22 | 1·11 | ·44 | ·64 | 8·1 | 33·9 | 4·28 | Grass, green, short, and bush. |
| | | Dec. 1934 | ·085 | ·39 | ·15 | 1·10 | ·41 | ·72 | 7·3 | 35·4 | 3·75 | Grass, green, short, and bush. |
| | | Mar., 1935 | — | ·48 | ·17 | ·64 | ·23 | — | 5·6 | 36·4 | 2·80 | Grass, mainly green, leafy, and bush: mostly bush. |
| | | June, 1935 | ·084 | ·59 | ·22 | ·94 | ·31 | ·40 | 8·5 | 31·0 | 3·63 | Grass, green, short, and bush; mostly bush. |
| Klipfontein...... | Humansdorp... | Jan., 1934 | ·11 | ·62 | ·19 | 1·43 | ·18 | ·31 | 9·2 | 28·4 | 4·09 | Grass, green, short, and bush; mostly bush. |
| | | Aprl, 1934 | ·12 | ·54 | ·27 | 1·38 | ·20 | ·35 | 10·7 | 34·4 | 4·70 | Grass, short, and bush; mostly bush. |
| | | July, 1934 | ·064 | ·84 | ·15 | ·93 | ·12 | ·22 | 7·5 | 33·1 | 3·86 | Grass, short, and bush; mostly bush. |
| | | Oct., 1934 | ·10 | ·64 | ·19 | ·94 | ·15 | ·24 | 7·0 | 29·8 | 3·51 | Grass, green, short, and bush. |
| | | Feb., 1935 | ·07 | ·65 | ·25 | 1·08 | ·35 | ·44 | 7·3 | 34·4 | 4·32 | Grass, mainly green, and bush; mostly bush. |
| | | May, 1935 | ·11 | ·48 | ·17 | ·98 | ·15 | ·13 | 8·0 | 34·1 | 3·10 | Grass, mainly green, leafy, and bush. |
| Groothoek No. 2. | George........ | Oct., 1934 | ·11 | ·40 | ·17 | 1·24 | ·30 | ·59 | 8·7 | 37·2 | 3·78 | Grass, green, and bush; mostly grass. |
| | | April, 1935 | ·052 | ·26 | ·12 | ·40 | ·12 | ·13 | 3·6 | 35·1 | 1·72 | Grass, leafy. |
| | | July, 1935 | ·10 | ·31 | ·14 | ·82 | ·08 | ·30 | 7·2 | 36·8 | 2·96 | Grass, mainly green, short. |
| | | Oct., 1935 | ·12 | ·32 | ·16 | ·94 | ·19 | ·45 | 7·4 | 36·2 | 3·17 | Grass, mainly green, leafy. |

### AREA O (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eastbrooke....... | George......... | Nov., 1934 | ·092 | ·22 | ·08 | ·80 | ·02 | ·11 | 6·5 | 34·7 | 1·87 | Grass, mainly green. |
| | | Feb., 1935 | ·089 | ·40 | ·10 | ·69 | ·09 | ·20 | 5·9 | 34·0 | 2·07 | Grass, leafy. |
| | | Aug., 1935 | ·056 | ·25 | ·10 | ·33 | ·04 | ·13 | 5·2 | 33·4 | 1·76 | Grass, mainly brown, short. |
| Kraaibos......... | George......... | Mar., 1935 | ·07 | ·27 | ·13 | ·70 | ·07 | ·13 | 5·1 | 36·7 | 1·97 | Grass, mainly green, short. |
| | | June, 1935 | ·074 | ·28 | ·13 | ·70 | ·03 | ·21 | 5·4 | 33·6 | 2·19 | Grass, mainly green, short. |
| | | Sept., 1935 | ·073 | ·37 | ·13 | ·72 | ·16 | ·34 | 6·4 | 27·8 | 2·85 | Grass, green, short. |
| Witvlei.......... | Piquetberg..... | April, 1934 | ·11 | ·58 | ·26 | 1·82 | 1·28 | 1·65 | 9·4 | 27·4 | 8·10 | Bush. |
| | | Aug., 1934 | ·40 | 1·12 | ·37 | 3·44 | 1·20 | 2·12 | 21·5 | 16·1 | 12·85 | Bush. |
| | | Nov., 1934 | ·16 | ·64 | — | 1·64 | 1·92 | 1·81 | 10·6 | 30·8 | 9·26 | Bush. |
| | | April, 1935 | ·11 | ·70 | — | 1·54 | 1·80 | 1·14 | 10·9 | 27·2 | 8·71 | Grass and bush; mostly bush. |
| | | Aug., 1935 | ·34 | 1·00 | ·30 | 2·90 | 1·12 | 1·47 | 19·3 | 21·4 | 9·94 | Bush. |
| | | Oct., 1935 | ·21 | ·72 | ·25 | 1·86 | 1·06 | 1·83 | 10·0 | 31·7 | 7·75 | Grass, mainly green, and bush. |
| Waschklip....... | Hopefield...... | April, 1934 | ·13 | 1·31 | ·41 | 1·42 | 1·08 | 2·13 | 8·2 | 26·4 | 9·10 | Bush. |
| | | Aug., 1934 | ·40 | ·45 | ·17 | 1·59 | ·03 | 2·70 | 18·3 | 16·9 | 14·45 | Bush. |
| | | Oct., 1934 | ·25 | 1·64 | — | 1·88 | 1·40 | 2·37 | 10·6 | 26·0 | 11·00 | Bush. |
| | | Feb., 1935 | ·21 | 1·37 | — | 1·85 | 2·76 | 4·41 | 10·3 | 26·9 | 14·10 | Bush. |
| | | May, 1935 | ·20 | 1·67 | — | 1·97 | 1·60 | 2·46 | 14·3 | 27·7 | 11·96 | Grass and bush; mostly bush. |
| | | July, 1935 | ·33 | 1·57 | ·71 | 2·22 | 1·68 | 3·16 | 17·8 | 18·3 | 13·35 | Bush. |
| | | Nov., 1935 | ·26 | 1·52 | ·55 | 1·58 | ·93 | 1·79 | 10·9 | 28·7 | 10·00 | Bush. |
| | | Jan., 1936 | ·28 | 1·65 | ·56 | 1·78 | 1·47 | 2·73 | 10·0 | 27·0 | 11·96 | Bush. |
| Malmesbury Commonage | Malmesbury.... | Dec., 1934 | ·09 | ·21 | ·12 | 1·51 | trace | ·25 | 7·9 | 34·5 | 2·97 | Grass, green, leafy. |
| | | May, 1935 | ·07 | ·27 | ·12 | ·64 | ·22 | ·28 | 5·8 | 43·5 | 2·4 | Bush. |
| | | Sept., 1935 | ·31 | 1·07 | ·30 | 3·16 | ·65 | 1·06 | 15·6 | 24·7 | 9·36 | Bush. |
| | | Oct., 1935 | ·14 | 1·03 | ·25 | 1·86 | ·47 | 1·07 | 8·0 | 37·8 | 7·02 | Bush. |
| Kransvlei.. ..... | Clanwilliam ... | Nov., 1934 | ·14 | ·25 | ·18 | 1·49 | ·65 | 1·25 | 6·7 | 37·7 | 4·95 | Grass. |
| | | Feb., 1935 | ·13 | ·18 | ·14 | ·93 | ·52 | ·74 | 4·0 | 36·1 | 3·38 | Grass. |
| | | May, 1935 | ·11 | ·42 | ·19 | 1·45 | ·34 | ·48 | 8·2 | 32·7 | 4·06 | Grass, mainly green, and bush; mostly grass. |
| | | Aug., 1935 | ·21 | 1·10 | ·24 | 2·43 | 1·07 | 1·66 | 14·5 | 21·5 | 9·02 | Bush. |
| Vlei Estates...... | Clanwilliam.... | Dec., 1934 | ·16 | ·45 | ·16 | 1·58 | 1·06 | 1·20 | 8·7 | 31·3 | 5·82 | Grass, leafy, and bush. |
| | | Mar., 1935 | ·09 | ·32 | ·16 | 1·37 | ·52 | ·10 | 6·7 | 36·7 | 4·42 | Grass, mainly green. |
| | | June, 1935 | ·11 | ·50 | ·21 | 1·23 | ·48 | ·77 | 10·0 | 31·8 | 4·50 | Grass, mainly, green. |
| | | Sept., 1935 | ·23 | ·71 | ·24 | 2·04 | ·60 | 1·08 | 13·4 | 30·3 | 7·00 | Grass, green, leafy, and bush; mostly grass. |

## AREA O (*continued*).

| Farm. | District. | Date. | P. | Ca. | Mg. | K. | Na. | Cl. | Crude Protein. | Crude Fibre. | Soluble Ash. | Description of Sample. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Patrysvlei........ | Clanwilliam.... | Jan., 1935 | ·21 | ·25 | ·25 | 2·02 | ·28 | 1·15 | 9·1 | 34·2 | 4·99 | Grass. green, leafy. |
| | | April, 1935 | ·19 | 1·16 | ·52 | 2·43 | ·88 | 1·30 | 11·4 | 30·1 | 8·90 | Grass and bush. |
| | | July, 1935 | ·16 | 1·16 | ·58 | 1·20 | 1·21 | 2·25 | 13·4 | 29·3 | 10·37 | Bush. |
| | | Oct., 1935 | ·14 | ·77 | ·27 | 1·35 | ·74 | ·97 | 10·6 | 26·8 | 5·88 | Grass, green, and bush. |
| Swartboskraal.... | Clanwilliam.... | Nov., 1934 | ·11 | ·39 | ·15 | ·98 | ·22 | ·42 | 6·4 | 34·3 | 3·15 | Grass, brown, and bush; mostly grass. |
| | | Feb., 1935 | ·06 | ·32 | ·10 | ·60 | ·14 | ·23 | 4·4 | 34·8 | 2·18 | Bush. |
| | | May, 1935 | ·096 | ·31 | ·18 | ·79 | ·35 | ·43 | 7·0 | 30·5 | 2·93 | Grass, mainly brown, and bush. |
| | | Aug., 1935 | ·19 | ·99 | ·36 | 2·44 | ·60 | ·94 | 12·5 | 30·1 | 7·77 | Bush. |
| Mariendal........ | Clanwilliam.... | Dec., 1934 | ·088 | ·49 | ·14 | ·99 | ·30 | ·45 | 6·5 | 38·6 | 3·46 | Grass and bush. |
| | | Mar., 1935 | ·082 | ·46 | ·17 | ·79 | ·24 | ·34 | 5·5 | 43·4 | 3·46 | Bush. |
| | | June, 1935 | ·09 | ·46 | ·19 | ·97 | ·35 | ·64 | 8·6 | 34·4 | 3·68 | Grass, mainly green, and bush; mostly grass. |
| | | Sept., 1935 | ·21 | ·87 | ·48 | 2·48 | 1·39 | 1·96 | 13·9 | 27·2 | 10·74 | Bush. |
| Wadrift.......... | Clanwilliam.... | Jan., 1935 | ·19 | ·74 | ·58 | 1·47 | ·51 | ·97 | 8·3 | 26·3 | 6·54 | Bush. |
| | | April, 1935 | ·17 | 1·02 | ·40 | 1·49 | 1·08 | 1·38 | 9·4 | 33·7 | 8·16 | Bush. |
| | | July 1935 | ·31 | 1·75 | ·45 | 2·42 | 1·14 | 2·46 | 18·0 | 26·0 | 12·15 | Bush. |
| | | Oct., 1935 | ·25 | 1·31 | ·38 | 1·85 | 1·41 | 2·18 | 11·8 | 23·2 | 10·33 | Grass, green, leafy, and bush; mostly bush. |

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# Iodine in the Nutrition of Sheep.
## Final Report.

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## INTRODUCTION.

ALTHOUGH it is universally recognized that Iodine is an essential element in nutrition, several workers have recently hesitated to advocate a general supplementation of iodine in the rations of live stock. It may well be argued that the continued administration of iodine may prove harmful to various internal organs. Malan *et al* (1935) drew attention to the increasing list of investigators who have become less enthusiastic about iodine, and some of whom have even sounded a warning in regard to the indiscriminate use of iodine in stock licks.

The work carried out at this Institute since 1932 [Malan *et al* (1932) and Malan *et al* (1935)] has not shown that the regular supplementation of small doses of potassium iodide proved beneficial to sheep. In fact, several of the ewes that received iodine aborted, or gave birth to clinically abnormal lambs. As abnormalities in regard to reproduction proved to be aggravated in the earlier work, it was concluded that the low vitamin A content of rations might have exerted an undesirable influence. It was, therefore, decided that further work should be done with the view of obtaining more conclusive evidence relative to the regular supplementation of iodine to sheep.

## DESCRIPTION OF EXPERIMENT.

Twenty 4-tooth merino ewes were selected for this experiment. These were divided into two conformationally uniform groups. All the sheep received the same basal ration, which from past experience has proved to be slightly above maintenance requirements for sheep weighing about 70 pounds, when kept under similar conditions. The ration consisted of: 300 gms. crushed yellow maize, 50 gms. blood meal, 50 gms. veld hay and 50 gms. greenfeed.

The sheep were fed in individual pens and managed according to the description given by Malan *et al* (1935). A stock solution of KI was prepared, consisting of 20 gms. of KI per 5,000 c.c. of water, and the sheep dosed daily as follows:—

Group I—Controls—received 12 c.c. of water.

Group II—received 12 c.c. of solution containing ·05 gms. KI.

In order to equalize handling and treatment in all sheep, Group I was dosed daily with 12 c.c. of pure water. The period of iodine supplementation was a relatively short one as may be seen in Fig. I. Four months after supplementation was commenced, the sheep were shorn and were then put to the rams. In view of the researches done by Roux (1936), which showed that merino sheep come into oestrum more regularly from December to February, the rams were left with the ewes for a period of three months.

## RESULTS.

### (*a*) *Feed Consumption.*

As a rule all the feed was eaten and weighing back of any feed which remained unconsumed only became necessary in such cases as were off feed for short periods. It may, therefore, be taken that the full ration was consumed throughout the period. The greenfeed was included in order to ensure an adequate supply of vitamin A, and consisted of such material as was available at the time, e.g. green oats, barley or maize stalks and leaves.

### (*b*) *Weights.*

The sheep were weighed monthly and the record of the weights are given in Figure I.

It will be noticed from the graph that the group which received KI weighed on an average 1·3 Kg. less than the control group at the commencement of the experiment. The difference in average weight between groups 1 and 2 gradually increased as the experiment progressed. Just before shearing all the sheep, this difference was 2·4 Kg. and the last weight recorded before the commencement of lambing indicates a difference of 3·0 Kg. in favour of the control group. A careful study of the curve shows that the widening gap may be attributed to a definite lag in average weight gain of the group that received the iodine supplement.

A far more severe drop in weight is registered in the case of the control group shortly after lambing than occurred in group 2. For an explanation the lambing chart, Table I, should be consulted.

From the data given in Table I it will be seen that seven lambs were born in Group I as compared with five lambs in Group 2. Two lambs were lost in Group I, the first on the day of birth due to a wrong presentation and the other two days after it had been born because the ewe refused to allow the lamb to drink. Five lambs were, therefore, reared in the control group.

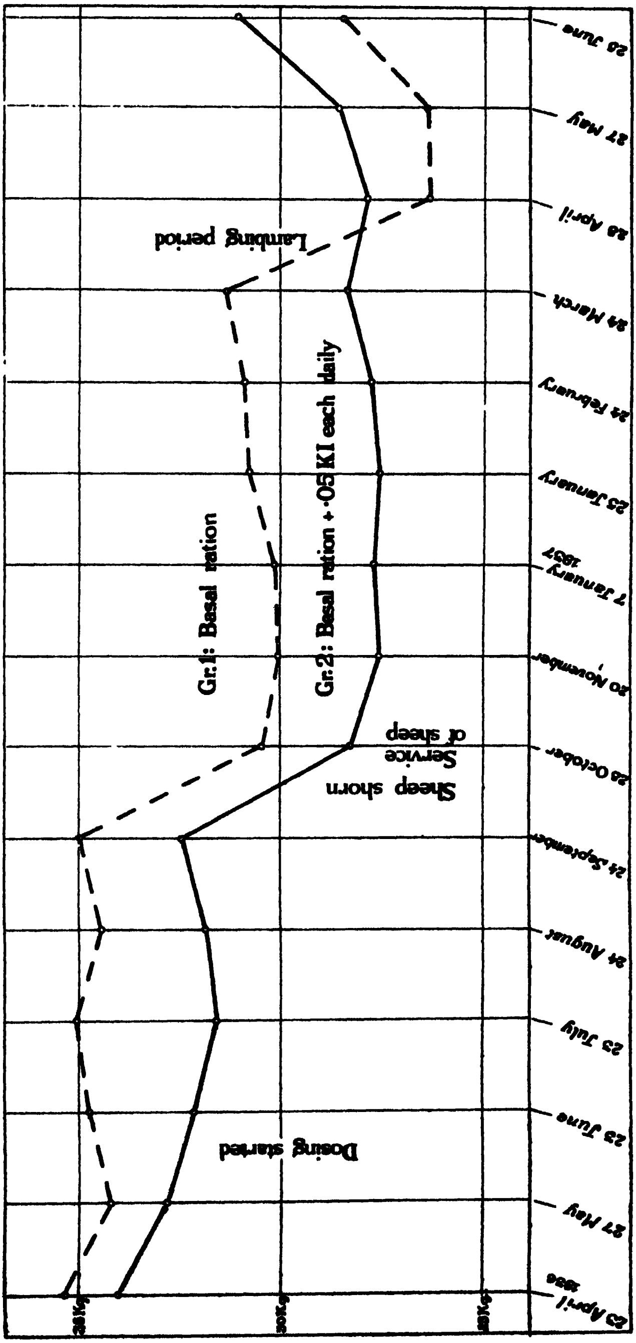

FIG. 1.—*Monthly Weights of Sheep.*

## TABLE I.

| Number of Ewe. | Date Served by Ram. | Date of Birth of Lamb. | Sex of Lamb. | Weight of Lamb at Birth. | Gestation Period. | Cause of Death of Lamb. | Date of Death of Lamb. | Cause of Death of Ewe. | Date of Death of Ewe. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|
| *Group* 1. | | | | | | | | | | |
| 40325 | 6/11/36 | 5/4/37 | Ewe | 7 lb. | 150 days | — | — | — | — | — |
| 40304 | 5/1/37 and during December | — | — | — | — | — | — | — | — | Not Pregnant. |
| 40344 | 16/11/36 | 18/4/37 | Ram | 6 lb. | 147 days | — | — | — | — | — |
| 40281 | 21/11/36 | 18/4/37 | Ram | 5½ lb. | 151 days | Ewe refused to take it | 20/4/37 | — | — | — |
| 40309 | — | — | — | — | — | — | — | Peritonitis | 3/11/36 | Before Service. |
| 40291 | 6/11/36 | 7/4/37 | Ewe | 8 lb. | 153 days | — | — | — | — | — |
| 40294 | 9/11/36 | 12/4/37 | Ram | 8½ lb. | 154 days | — | — | — | — | — |
| 40271 | During December | 2/5/37 | Ram | 7·3 lb. | ? | — | — | — | — | — |
| 40279 | 28/10/36 | — | — | — | — | — | — | Enteritis and Suspected Heartwater | 8/5/37 | Not Pregnant. |
| 40337 | 19/11/36 | 17/4/37 | ? | ? | 151 days | Wrong Presentation | 17/4/37 | Dystokia | 17/4/37 | — |
| *Group* 2. | | | | | | | | | | |
| 40326 | 22/1/37 | 24/6/37 | Ewe | 6 lb. | 154 days | — | — | — | — | — |
| 40319 | — | — | — | — | — | — | — | — | — | Not Pregnant. |
| 40350 | — | — | — | — | — | — | — | — | — | Not Pregnant. |
| 40341 | — | — | — | — | — | — | — | — | — | Not Pregnant. |
| 40278 | ? | 8/4/37 | Ewe | 3½ lb. | ? | Deformed | 8/4/37 | — | — | — |
| 40331 | 16/11/36 | 23/4/37 | Ram | 8½ lb. | 159 days | Abortion | 23/4/37 | — | — | — |
| 36467 | 28/10/36 | 26/3/37 | Ram | 5½ lb. | 150 days | Full Time Abortion | 26/3/37 | After Effects of Abortion | 12/4/37 | — |
| 40318 | 25/10/36 | — | — | — | — | — | — | — | — | Not Pregnant. |
| 40312 | — | — | — | — | — | — | — | Pneumonia | 1/8/36 | Before Service. |
| 40306 | 22/1/37 | 24/6/37 | Ewe | 4½ lb. | 154 days | — | — | — | — | — |

Out of the five pregnancies in the group that received potassium iodide, there were two abortions and one deformed lamb was born that lived for a few hours only. In consequence only two lambs were reared in group 2.

In each group one ewe died early in the experiment so that this equalized conditions, especially as these ewes had not been served. Notwithstanding the length of the period that the rams were allowed to run with the ewes, conception apparently did not take place in the case of two ewes in Group 1 and four ewes in Group 2.

When all the factors in regard to the lambing are taken into consideration, it may be readily appreciated why the average group weight in Group 1 dropped below that of Group 2 during and after lambing. In spite of the loss in weight and the larger number of lambs that were being suckled in Group 1, this group showed a remarkable weight recovery during the last month of the experiment.

At the conclusion of the experiment one ewe in each group was submitted for a complete pathological examination by Dr. A. D. Thomas, Pathologist. Perhaps the most noticeable feature in the report received in regard to this examination refers to the skin and wool:—

> *Skin.*—Control—Normal.
>
> Sheep that received KI.—The hair follicles appeared closer together and deeper than in the control. There was evidence of a diffuse inflammatory process with occasional isolated eczematous crusts on the surface. It seemed as if there was greater activity of all epithelial cells: e.g. The sweat glands were thick-walled.
>
> *Wool.*—Control—There was a recent break, otherwise the thickness was fairly uniform.
>
> In the sheep that received KI the thickness varied somewhat. Eczematous crusts and mild inflammation of the skin was present.
>
> The thyroids, which were examined in both ewes and lambs, showed cell changes but not the usual characteristic enlargements. No definite information could, therefore, be gained by the pathological examination of the thyroids.

## DISCUSSION.

A consideration of all the data collected considerably strengthens the conclusions arrived at in past work at this Institute. Figure I and Table I clearly show that the daily administration of 0·05 gms. of potassium iodide did not benefit significantly a group of ten merino sheep. Although the weight curve as well as lambing chart suggest that potassium iodide supplementation had a detrimental effect, the results are not so marked as was the case when other deficiency factors, e.g., vitamin A or phosphorus, were also present as shown in the past work. There is little doubt therefore, that iodine supplementaion is not warranted and that its deleterious effects are aggravated in the presence of other nutrient insufficiencies. The work of Williams *et al* (1938) drew attention to the occurrence of a condition among lambs where there was thyroid enlargement, nervous symptoms and as found by Malan *et al* (1932) these lambs lived only for a few days. The most acute deficiency in both instances probably was vitamin A. The supply of green succulence may not be adequate, consequently the intake of vitamin A would be low for pregnant ewes during the late winter months. During these months natural grazing may be lacking in quantity and in nutrients such as phosphorus and protein. Iodine supplementation in such circumstances will prove more harmful than when rations adequate in all nutrients are fed. The relatively short gestation period of the ewe may fall almost entirely within the interval of grazing deficiency or drought. The result not infrequently is the occurrence of a condition in lambs which appears to have a bearing on an iodine deficiency but which may be entirely unassociated with it. Goitrous conditions, as a result of an iodine deficiency, are however very rarely if at all seen among farm animals in this country. It is hoped that more light will be cast on this question when the present experimental work on poor nutritional conditions in relation to the production of disease has been concluded.

## SUMMARY.

1. Two groups of 10 merino ewes were fed the same adequate basal ration with the exception that one group received an addition of 0·05 gms. each daily of potassium iodide.

2. A slight depression of weight and greater irregularity in regard to the reproduction was shown by the group that received the iodine supplement. The detrimental effects, however, were not as marked as recorded in previous work where other deficiencies, especially vitamin A, undoubtedly exercised an aggravating influence on reproductive abnormalities.

3. The indiscriminate use of iodine supplements for sheep is not recommended.

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# The Significance of Fluorine Traces in Natural Waters and a Proposed Method to Effect their Removal.

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THE ENDEMIC HYPOPLASIA of the permanent teeth, known as chronic endemic dental fluorosis, was first described by Eager (1901). McKay (1916) established this defect of human dentition as a water borne disease. The causative etiological factor was proved beyond doubt by Smith (1931), Churchill (1931) and Velu (1931), as being associated with the continual ingestion of toxic amounts of fluorine in the water used for cooking and drinking purposes, during the period of calcification of the affected teeth. The permanent teeth in particular are affected, although in areas of marked severity, the high fluorine ingestion is manifested by permanent damage to the deciduous teeth. As the enamel-forming ameloblasts cease functioning at the time of the eruption of a tooth, this unsightly phenomenon is a permanent physical disfigurement.

Since 1931, when fluorine traces in the natural water were established by the American workers as the causative factor in the production of mottled enamel, fluorine toxicosis has been recognized in America as a public health problem.

A quantitative, epidemiological-chemical study was carried out by the American Public Health Service to determine the minimum threshold of toxicity, in other words the maximum amount of fluorine permissible in a domestic water supply.

In the light of present knowledge, it appears that mottling of the permanent teeth is caused by using water, containing fluorine in excess of one part per million, for both cooking and drinking purposes during the period of dental susceptibility.

In contrast to the findings of the American workers, Sugawa (1938), observed a high incidence of mottled teeth amongst the inhabitants of the island of Sakurasima, the fluorine content of the water ranging from 0·7 to 1·0 p.p.m. Even at a fluorine concentration of 0·3 p.p.m. this worker observed a dental fluorosis amongst the natives of the Kagosimma prefecture in Japan.

Zelmanova (1937), examined the teeth of 4,000 children living on the shore of lake Immanda in Russia. The fluorine content of the drinking water ranging from 0·02 to 0·9 p.p.m. In approximately 6 per cent. of the children he observed curious nebulae, accompanied by calcareous spots on the teeth. In conjunction with this slight defect, he frequently observed the occurrence on the teeth of these children of the Pristleef Tarnish, a stain due to a chromogenic fungus. Zelmonova states that fluorine is not the causative factor in this defect, but that it is due to a decalcification of the dentine, a condition observed in areas where the mineral content of the water is low.

Dean (1938) observed that different individuals of even a homogeneous group are diversely affected by the same concentration of fluorine in the drinking water. He states that certain children have no mottled teeth, while others in the same family and using the same water are definitely affected. According to Dean this phenomenon is merely a normal manifestation of the operation of the law of normal biological variation. In the affected Amirillo area in Texas, Dean (1938) examined 289 children, all of whom continuously used the municipal water for both cooking and drinking purposes. Of the children examined the teeth of 9 were found to be normal, 19 questionable, 44 showed very mild, 81 mild, 98 moderate, 32 moderately severe and 6 showed severe mottling. These figures are based on the classification propounded by Dean (1934) for mottled enamel. It is at once evident, that this frequency distribution, represented graphically, roughly conforms to the characteristic monomodal curve of variation. The highest percentages being intermediate, with the initial and terminal ones the lowest.

The distribution of this disease is almost universal, Australia being the only continent from which dental fluorosis has not been reported. The reports by the various workers in the field of fluorine toxicosis, in America, Argentine, China, England, Spain, Italy, South Africa, etc., are to the effect, that the ingestion of fluorine in the drinking water in a concentration exceeding one part per million, manifests itself on the teeth calcifying during this period.

The characteristic features of dental fluorosis are not the same as those encountered in other disturbances, such as avitaminoses A (Wolbach, 1933), rickets (Erdheim, 1914), parathyroidectomy (Toyofuku, 1911), hyperthyroidism (Schour, 1934), and hypophysectomy (van Dyke, 1932). The most outstanding feature of fluorosis of the teeth, is the selective action of fluorine on the enamel, especially the primary accentuated incremental layers in the enamel. This selective action on the enamel is of special interest in the light of Erdheim's calcio protective law, stating that some tissues are more protected against disturbances in calcium metabolism than others. Thus as a rule enamel shows disturbances less frequently than does dentine.

Mottling of the teeth is chiefly characterized by chalky white patches distributed irregularly over the surface of the tooth. These chalky areas are as a rule well defined and may readily be differentiated from the rest of the tooth surface. In many instances the whole tooth represents this dead white, turbid, unglazed appearance. As a result of the loss of their normal translucency the teeth glare unnaturally when the mouth is open.

In this country, especially in the rural areas of the North-Western Cape Province, dental fluorosis is chiefly characterized by marked parallel striations across the upper and lower central and lateral incisors, extending in many cases to the cuspids, the chalky areas being more or less confined to the molars and premolars. In the spaces between these striations the tooth surface retains its naturel translucency and porcelain finish to a great extent. Sometimes the striations are very fine and irregular and can only be observed as fine intersecting lamellae. By force of circumstances the inhabitants of these affected areas are subjected to a more or less nomadic existence, which may to a certain extent account for the characteristic type of mottling encountered.

In the most severe forms of dental fluorosis, there is a marked loss of enamel, accompanied by pronounced pitting, both confluent and discrete, giving the tooth surface a corroded appearance. This marked influence of fluorine causes atrophy of the entire enamel organ, and may result in aseptic necrosis.

In the affected countries mentioned, no actual changes are observed in both size and shape of the affected teeth. The only other oral abnormality encountered is a tendency for the teeth to erupt somewhat later than in non-affected areas and a tendency towards gingivitis, in localities where the fluorine content of the water is excessively high.

As already pointed out, tooth fluorosis is a defect mainly of the permanent teeth. Deciduous teeth are also subject to fluorine damage, usually concomitant with the ingestion of large amounts of fluorine through the medium of the drinking water. Roholm (1937) observed mottling in the permanent teeth of children suckled by mothers working in cryolite factories. The deciduous teeth of these children are perfectly normal.

The fact that the temporary teeth are rarely affected, may be ascribed to a very rapid calcification and eruption. The calcification of the baby teeth is in process during early foetal life; thus, the enamel is protected from a fluorine interference by a nutritive supply dialyzed through placental osmosis.

In this country, Ockerse (1939) encountered 22 instances ot a pronounced mottling of the deciduous teeth in the affected localities of the North Western Cape Province. The fluorine content of the respective waters is still pending analysis.

Mottled teeth may or may not become stained afterwards. The stain is frequently confused with the enamel defect itself, but is a secondary phenomenon. The stain which is presumably due to a secondary infiltration shows considerable variations in colour, ranging from almost black to yellow. As a rule the stain is not present in all the teeth, being more pronounced on the upper lateral and central incisors. The stained areas are mostly localized to the labial surfaces of these teeth, and have a general tendency to follow the lip-line, thus suggesting that prolonged exposures to light may be a factor in its development. The behaviour of the stain during calcination suggests an organic nature. The stain generally deepens with age.

The enamel of adult teeth is unaffected by fluorine, the composition of the dentine, however, is liable to change and may thus be affected.

In the more advanced stages of dental fluorosis, severe pitting and loss of enamel may result in a general carious condition of the teeth. Isolated instances of such a condition were observed by Ockerse (1939) in this country in urban areas with a 100 per cent. incidence of mottled teeth amongst school children. This worker further reports, that the incidence of caries in the affected areas is exceedingly low.

Dean (1938, a), in America and Ainsworth (1933) in England, pointed out that the use of domestic waters in itself capable of producing mottled teeth, is concomitant with a lower incidence of caries.

The incidence of a pathological condition of the teeth of certain domestic animals, under natural conditions, has been reported from North Africa, Texas, and the Argentine Republic. Particularly those animals requiring several years for the calcification of their permanent teeth, are affected.

Van der Merwe and Malan (1939), observed in the Kenhardt-Upington districts that the ingestion of water containing up to 8 p.p.m. fluorine, has no visible effect on the calcification of the teeth of cows, goats, sheep and donkeys. Velu (1938). states that drinking water containing 7 p.p.m. fluorine as $CaF_2$ did not affect the teeth of animals. Steyn (1937) believes that a fluorine content of at least 4-6 p.p.m. in the drinking water is necessary to cause enamel defects in animals.

It seems fairly definite, that water containing fluorine in quantities sufficient to cause severe mottling in humans, will not affect the teeth of animals.

It has been known for a long time that the continual ingestion of large amounts of fluorine, adversely affects the calcium-phosphorus metabolism of animals.

Bartolucci (1912), described a disease amongst cattle on a farm in the environment of a superphosphate factory in Italy. Clinically this disease, which Bartolucci termed osteitis, vonforms to the classical osteomalacia. Bartolucci associated this disease etiologically with the fluorine containing gases emanating from the factory. He states, that water, from a well sunk near the canal leading off the factory effluents, contains fluorine, and the interesting observation was further made, that the affection amongst the animals disappeared when the water from the town mains was used for drinking purposes.

Smith *et al* (1935) in America were unable to establish any impairment in the Calcium-phosphorus metabolism of young girls severely affected by tooth fluorosis. Their findings are based on balance trials. These workers state that the continual ingestion of fluorine through the medium of the drinking water in quantities sufficient to produce pronounced mottling of the teeth, in no way disturbs the body's ability to metabolize calcium and phosphorus.

In Texas, Lemmon (1934) observed that babies in the affected Amirillo area show greater tendency to bowing of the legs, even in the face of constant anti-rachitic therapy, thus supporting the theory that fluorine even in very small concentrations interfere with the general calcium and phosphorus metabolism.

In diametric opposition to the findings of the American workers, Shortt, McRobert and Barnard (1937), report the incidence of endemic fluorosis of a unique character, in the Madras Presidency. They state this condition to be prevalent in areas, amongst natives, who have been subjected for periods of forty years or more to the influence of drinking water, containing comparatively large quantities of fluorine. In the initial stages this disease is manifested by mottling of the permanent and sometimes the deciduous teeth. The affected teeth are in no way superior to or worse than the teeth of children in non-affected areas. Apart from the dental defect the children drinking these respective waters do not appear to suffer in any way. From birth until approximately thirty years a dormant period is observed, during which no ill effects are being encountered. At about thirty years of age the first symptoms of poisoning set in. This is manifested by a general recurrent tingling sensation in the limbs and sometimes in the entire body. Pain and stiffness next appear, especially in the lumbar region of the spine. The stiffness increases until the entire spine including the cervical region appears to be one continuous column of bone, producing a condition of poker back. Ultimately the spine loses its flexibility, accompanied by stiffness of various joints. The bony structure of the thorax is affected to a marked degree, the ribs become rigidly fixed at their junction with the spine, with the result that breathing becomes entirely abdominal. In the advanced stages of this disease, the victims exhibit a definite cachexia, loss of appetite and emaciation. Ultimately there is a loss of sphincter control and impotence is common. At this stage the patient is completely bed-ridden, death following, usually due to some intercurrent disease. Radiological findings show excessive calcification of tendons and ligaments, the presence of osteophytic outgrowths from various bones and almost complete synostosis of various joints. The biochemical estimation of serum calcium, phosphorus and phosphatase indicates a favourable condition for abnormal deposition of bone.

The clinical and radiological findings bear a close analogy to the observations of Flemming—Moller and Gudjonnson (1932), who encountered a marked osteosclerosis in workers in a cryolite factory in Denmark.

This report by Shortt, McRobert and Barnard is of great interest as it is the only one encountered in the literature, describing the devastating effect of water borne solute fluorides.

The nutritional aspect relevant to the above mentioned incidence of fluorosis, should, however, be considered. It has repeatedly been demonstrated that nutritional factors play an important part in the manifestation of symptoms of fluorine intoxication. Schlick (1911) reported that frogs receiving toxic doses of NaF may be protected by means of $CaCl_2$. Hauck, Steenbock and Parsons (1933), showed that the toxic effects of fluorine administration was less on a high calcium ration than on a low calcium ration. Elmslie (1936) pointed out that the addition of $CaCO_3$ to the ration of the rat, increased the level of toxicity of fluorine. Schulz (1938) found that the addition of cod liver oil to the diet of the rat, subjected to fluorine ingestion, tends to ameliorate the toxic effects of the fluorine. On the other hand, Phillips, English and Harts (1935), found that the toxicity of NaF to chicks, fed orally or injected intraperitoneally in water solution was much increased when desiccated thyroid was fed. They observed that non-toxic doses of thyroid became toxic when NaF was fed, and non-toxic doses of NaF became toxic when fed in conjunction with desiccated thyroid.

Chanelles (1928), found that when iodides are fed in conjunction with fluorides, the resultant fluorosis is much accentuated. This apparent relationship between fluorine and thyroxin in the animal body may be a factor governing chronic fluorosis.

A dental and mandible disease known as Darmous, occurs amongst herbivora in the phosphate zones of North Africa. This disease is a chronic fluorine intoxication affecting the general calcium-phosphorus metabolism. The form of Darmous occurring in man must be regarded as the most severe type of dental fluorosis, and is accompanied by pronounced developmental anomalies. The teeth may be delayed in eruption, and a marked dystrophy of the permanent teeth is observed, resulting in definite changes in the actual size and shape of the teeth. In both man and animal the terminal stages of this disease are accompanied by difficulties in mastication and increased sensitivity towards cold water. Inflammation of the gingiva often develops. Strictly speaking, however, Darmous is not a water borne disease. Roholm (1937) observed that the soluble fluorine fraction in the water of the endemic areas is comparatively low. Gaud and Charnot (1934) pointed out that the main factors involved in the production of Darmous is the drinking of water contaminated with phosphate suspensions, and chiefly the ingestion of vegetation covered with phosphate dust.

A dental and bone disease, termed Gaddur, is endemic in Iceland. Accounts of this strange disease are encountered in Icelandic literature dating back to the year 1,000 A.D. The natives found that domestic animals turned sick and died following eruptions of the volcanoes Hekla, Katla and Askja. The symptoms disappeared when the animals were taken indoors and fed hay reaped before the eruption. This disease which has played a great rôle in Iceland's economy, is encountered up to a period of twelve years following volcanic eruptions. The chief factor in the production of Gaddur is the ingestion of pasture contaminated by volcanic ash, intoxication through the medium of the drinking water being of secondary importance.

The true channels of the fluorine attack on the teeth are still rather obscure. It is a well known fact that dental fluorosis is accompanied by an increase in the fluorine content of the affected teeth. Whether the fluorine is deposited as the molecular $CaF_2$ or whether substitution of fluorine for the carbonate, chloride or hydroxyl radicles takes place in the isomorphous intermixtures of the various apatites comprising the bony matrix, is still a matter of conjecture.

Smith (1933) pointed out that in the teeth of rats fed NaF in the ration, the percentage of Ca, and the ratio of Ca to P as obtained by chemical analysis are remarkably similar to the calculated formula of the theoretical collophane, $3Ca_3(PO_4)_2.2CaX$.

Rogers (1922) describes fossil bones, known for a long time to be high in fluorine content, as collophane, to which he assigns the following formula $3Ca_3(PO_4)_2.(1\text{-}2)Ca(F_2CO_3SO_4O).XH_2O$.

Reynolds and Corrigan (1938), by means of X-ray diffraction studies, observed that the teeth of rats fed fluorine were heterogeneous, being mixtures of normal apatite like materials and $CaF_2$. The teeth are not uniformly orientated along the fibre axis, accompanied by an enlargement of the apatite crystals.

Bergara (1929), Chanelles (1929) and Pavlovic (1932), expressed the belief that the alterations observed in the teeth must be ascribed to endocrine factors. According to these workers, the fluorine acts directly on the parathyroid glands, and thus secondarily produces changes in the teeth. They base their claims on the fact that apparently similar changes are noted in the rat incisor in cases of fluorine feeding and parathyroidectomy.

This theory was, however, discredited by Hauck, Steenbock and Parsons (1933). Sutro (1935) found that parathyroid extract administered up to 700 units per day over a period of 2-3 months neither retarded nor prevented the appearance of striped enamel.

Schour (1934) pointed out that the amount of fluorine sufficient to cause dental changes is very small compared to the total ionized calcium content of the blood. It is, therefore, not likely that the calcioprive effect of the fluorine would be sufficiently great to disturb the calcium-phosphorus metabolism appreciably. According to Schour's postulate, the fluorine has a very prompt and direct influence on the formation and calcification of enamel and dentine, particularly the enamel forming cells.

Fluorides and silico fluorides exhibit an amazing reactivity towards certain enzymatic processes, in some instances causing an almost complete inhibition and in others a pronounced stimulation. Ewig (1929) has shown that in isolated tissue both anaerobic and aerobic glycolysis is greatly inhibited by NaF. Fluorine has an inhibitory effect on the lactic acid synthesis occuring during muscle metabolism. On the other hand Doby (1914), found that the amylase of the potato was powerfully stimulated by NaF.

According to Smith (1935), fluorine does not exert its characteristic damage through its effect on the enzymatic phosphatase reaction concerned in tooth and bone formation. An increase in plasma phosphatase cannot be considered a criterion in fluorine toxicosis, as suggested by Phillips (1932).

The first report on the histology of this disease is that of Black (1916), who noted that the identifying characteristic was the absence of the interprismatic cementing substance between the enamel rods. Williams (1923), confirmed the observations of Black, but states that the enamel rods themselves are imperfectly calcified. He also observed the presence of imperfectly fused granules and some spherical globular masses which are identical with the calciospherites encountered in completely calcified forming enamel.

Beust (1925), called attention to the fact, that in addition to the enamel the dentine is likewise affected, a condition which he termed mottled dentine. Ainsworth (1933,a), confirmed the fiindings of Beust by reporting the occurrence of imperfectly calcified dentine with interglobular spaces such as may be encountered in ordinary cases of hypoplasia. Ainsworth (1933,a) noted that the pitting of the enamel surface may readily be explained as a breaking off of the ends of the enamel rods, weakened by the loss of the interprismatic substances.

Erausquin (1934), reports that the permeability of mottled enamel may be compared to that of immature, unerupted, normal enamel. The permeable zone characterizing mottled enamel is always the most external, its intensity diminishes from the outside inwards.

## FLUORINE COMPOUNDS IN NATUREL WATERS AND THEIR ORIGIN.

The actual chemical nature of fluorine compounds present in drinking water is of some interest to the chemist, but apparently of no great practical significance.

In acute fluorine toxicosis studies in animals, various workers have observed that the attainment of gross symptoms of intoxication is definitely associated with the chemical nature of the fluorine compound used. Thus is was established that twenty times as much $CaF_2$ is needed to produce the same degree of severity of the symptoms caused by NaF, with $NH_4F$ and $Na_2SiF_6$ being of the same order of toxicity as NaF during the same period.

Kemf and Nelson (1936), observed that $CaSiF_6$ and $CuF_2$ caused mottling of the rat incisor, whereas the ingestion of $AlF_3$ did not produce this defect. Similarly in the field of the organic fluorides, fluoro naphthalene produced mottling, the ingestion of p-p di-fluorobiphenyl-p-fluoro-benzoic acid on the other hand has no effect of calcifying enamel.

In the light of present knowledge it appears that in dealing with the ingestion of small quantities of fluorine over extended periods of time, the actual chemical combination of the fluorine compound present is of secondary importance, whereas the physical state in which the fluorine is ingested is the primary factor governing the development of defective enamel.

Marcovitch (1938), established a marked difference in the accumulative effect of fluorine in rats subjected to a sodium fluoride intake equivalent to 4 p.p.m. of fluorine in the drinking water in one group and incorporated to the same fluorine equivalence as cryolite in the diet in a second group.

Bowes and Murray (1938), consider the fluorine contained in food supplies to be less dangerous than the fluorine derived from water origin.

Dean (1938, *b*), states that there is definite evidence implicating $CaF_2$ in solution as the sole factor in the production of mottled enamel in America. In America, however, fluorine concentrations in excess of 25 p.p.m. in the drinking water have been reported, a figure which cannot be explained when the solubility product of $CaF_2$ is taken into consideration. Assuming the postulate of Dean to be correct, then the high fluorine figures reported by the American workers must be considered a reflection of the pronounced disposition of fluorine compounds towards the formation of complexes.

In certain parts of Northern Africa, the natural waters contain fluorine due to percolation through or stagnation in the phosphate deposits, the fluorine in all probability passing into solution as $CaF_2$.

In Iceland, the different volcano environs are subjected to fluorine contamination, with the result that both fluorides and silico fluorides may be expected in the natural waters.

Fluorine compounds are of comparatively common occurrence in the outer layers of the earth's crust, especially as minor constituents of eruptive rocks and in conjunction with the universal distribution of natural phosphate deposits.

In a computation of the average chemical composition of eruptive rocks, Clarke and Washington (1924), place fluorine in the twenty-second position in the order of the ranking of the elements. According to these workers, fluorine constitutes 0·03 per cent. of eruptive rocks. Amongst the numerous rock forming minerals containing fluorine the most common are, lepidolite zinnwaldite, two lithium micas containing up to 7 per cent. fluorine, fluorspar, tourmaline, fluo-apatite, topaz and cryolite.

If the igneous rocks are in an unaltered and preserved condition, leaching and consequently fluorine contamination of the ground water cannot take place. If the rocks are, however, highly weathered and disintegrated as is the case with the old Archean Zwasiland granites of the North Western Cape, ground water may be brought into intimate contact with fluorine bearing strata.

In contact zones surrounding great masses of eruptive rock, it is observed that migration of some of the constituents of the magma into the country rock takes place. In studies of contact metamorphism, fluorine was found to be one of the elements subjected to transference. Especially limestone contacts are ready recipients of fluorine due to the binding powers of the former. In the metamorphic limestone of Monte Somma in Italy, the following fluorine bearing minerals were found, apatite, chondrodite, clino-humite, cuspidine, fluorspar, humite, vesuvianite, tourmaline, koppite and topaz.

Phosphorite and phosphatic limestone are two naturally occurring amorphous phosphates found in gigantic deposits in various parts of the world. The fluorine content ranging from 2-4 per cent. Water percolating through beds of phosphorite apparently exhibits no marked leaching properties as far as fluorides are concerned. Roholm (1937), pointed out that the fluorine figure of waters from the phosphate zones of North Africa ranges from 0·02-1·0 p.p.m. Of great importance however is the fluorine content of the suspended material in the water. That Darmous is not primarily produced by solute fluorides in the drinking water may be deducted from a report by Gaud, Charmot and Langlais (1934), to the effect that Darmous does not occur in areas where the fluorine content of the soil is less than 200 p.p.m.

Dean (1935) observed mottled enamel amongst cattle in Texas, where large phosphorite deposits are encountered.

That phosphorite may be instrumental in raising the fluorine content of ground water to a dangerous level, was demonstrated by Phillips and Hart (1934), who found a fluorine content of 1·7 p.p.m. in water draining from lands on which rock phosphate was used as fertilizer. Strangely enough, superphosphate, according to these workers, does not cause any significant increase in the fluorine content of drainage waters.

Thus far, no dental fluorosis has been reported from areas in South Africa where wavelite is found in vast deposits.

In areas of volcanic activity, the fluorine compounds present in the gas emanations may find their way into the natural waters of the volcanic environs. The presence of both HF and $SiF_4$ have repeatedly been demonstrated in volcanic exhalations, while the gas deposited incrustations about volcanic vents and fumaroles, contain up to 85 per cent. $NH_4F$.

In one locality in America, Mastodon bones from the Cenozoic era were suspected of contaminating the ground water with fluorine.

If the wide distribution of fluorine compounds in nature is taken into consideration it is only natural to assume the presence of traces of this element in many waters.

The formation of mottled enamel can readily be prevented, but there is no known cure once defective enamel sets in. The stain, due to its organic nature can temporarily be bleached by various oxidising agents, but the nebulae on the teeth and the general enamel defect is of a permanent nature.

Prior to the establishment of the etiological factor in this disease, prevention has been accomplished in America by simply changing the water supplies of the cities of Oakley (Idaho) and Bauxite (Ark.). A change of water supply is not always practical, but at the same time it is well to bear in mind that the only portion of the population in need of protection, is children from birth to eight years of age, and women during pregnancy—the latter precaution being necessary only in localities where the fluorine content of the water is excessively high.

The logical approach to the solution of this problem is to adopt a method of treating the affected waters by chemical or physical means to effect the removal of the toxic fluorides.

This problem has received the attention of the numerous workers and encouraging results have in many instances been attained. Various chemical compounds were investigated in regard to their mode of action towards solute fluorides. In the literature, the following attempts to defluorinize natural waters are mentioned. $Al_2(SO_4)_3$ (Boruff, 1934), Defluorite (Hess and Swopp, 1937), activated carbon (McKee and Johnson, 1934), activated alumina (Lindsay, 1936), activated MgO (Elvove, 1937) were used in filters.

The majority of these methods are costly and reliable results are not always obtained.

A more rational approach to the problem is to adopt as principle the great affinity exhibited by fluorine towards the tertiary phosphate complex. As far back as 1805, Morichini demonstrated this principle by reporting the very high fluorine content of a fossil elephant tooth found outside Rome, a phenomenon caused by the continual infiltration of fluorine from ground water origin. Margaret Smith (1938), working along these lines, advocates a method adopting a specially prepared bone product as a medium through which the fluorine contaminated water may be filtered. For limited supplies of water, low in total salt content, this method proved excellent in the hands of the author. The active principle is rapidly inactivated, and a constant check on the fluorine content of the filter effluent, is imperative, to ensure a safe water. On account of the fact that the active principle is poisoned in a comparatively short period of time, a continual regeneration of the bone product is necessary.

Adler, Klein and Lindsay (1938) found a tri-calcium phosphate used in conjunction with a filter bed, satisfactory for the removal of fluorine from water. Their product is essentially a mixture of hydroxy apatite and tri-calcium phosphate, and is prepared from high purity phosphoric acid and milk of lime. McIntire and Hammond (1938), stressed the possibility of exploiting baking powders and superphosphates as the calcium phosphate source to effect the removal of fluorides.

## PROPOSED METHOD OF REMOVAL OF FLUORIDES FROM NATURAL WATERS.

In the determination of the titratable acidity of aqueous solutions of superphosphate, it was observed by the author that the soluble fluorine fraction suffers a reduction, presumably due to either a precipitation with the phosphate complex as an apatite or as a result of adsorption. The method advocated here to effect the removal of fluorine from water is based on this principle, which comes into operation when superphosphate in a modified form, is incorporated in the affected water and a tertiary phosphate is subsequently precipitated in the aqueous medium by the addition of a basic hydroxide.

The products adopted in this investigation are the ordinary commercial superphosphates, comprising the 17, 19, 20 and 40 per cent. water soluble $P_2O_5$ varieties.

The water soluble selenium, boron and arsenic content of these products were found to be entirely negligible. Selenium and boron are both present in the mother rock from which the superphosphates are manufactured. The fate of these elements during the manufacturing process is still uncertain. Apparently they are partially expelled as their respective fluorides since these elements are only present in minute traces in the final product.

Superphosphate production by means of pyritic and lead chamber, volcanic sulphur-sulphuric acid, results in an arsenic containing final product. The use of sulphuric acid prepared from secondary sulphur in the contact process safeguards the superphosphates from an arsenic infiltration.

A sample of each respective superphosphate was ground to an impalpable powder to ensure a homogeneous product being obtained.

As a preliminary investigation the behaviour of the sulphate and fluorine compounds present in superphospates was studied under the conditions prevailing in the proposed method.

Aqueous solutions (using distilled water) were prepared of double superphosphate (40 per cent. water soluble $P_2O_5$). The concentrations used are shown in Table I. Solid $Ca(OH)_2$ was added to these solutions in quantities just sufficient to develop the maximum colour of added phenolphthalein.

TABLE I.

| Solution No. | Superphosphate Gr.p.lit. | $Ca(OH)_2$ Gr.p.lit. | Initial F. p.p.m. | Residual F. p.p.m. | Initial $SO_4$ p.p.m. | Residual $SO_4$ p.p.m. |
|---|---|---|---|---|---|---|
| A............... | 10 | 4·03 | 34·3 | 0·75 | 410 | 88 |
| B............... | 10 | 4·03 | 34·3 | 0·28 | 410 | 51 |
| C............... | 2 | 0·81 | 12·8 | 0·34 | 113 | 30 |

Solutions A and C were allowed to stand for a period of 24 hours with occasional agitation.

Solution B was boiled for a period of 10 minutes and the precipitate allowed to settle.

From the table it is evident that both the solute fluoride and sulphate from superphosphate origin suffer a marked reduction. The results obtained for the 17, 19 and 20 per cent. varieties of superphosphate are less favourable. The results obtained for 17 per cent. superphosphate are tabulated in Table II. Analogous results being obtained in the case of the other two phosphates.

TABLE II.

| Solution No. | Superphosphate Gr.p.lit. | Ca $(OH)_2$ Gr.p.lit. | Initial F. p.p.m. | Residual F. p.p.m. | Initial $SO_4$ p.p.m. | Residual $SO_4$ p.p.m. |
|---|---|---|---|---|---|---|
| A................ | 10 | 3·9 | 24·7 | 0·82 | 1,284 | 860 |
| B................ | 10 | 3·8 | 24·7 | 0·56 | 1,284 | 834 |
| C................ | 2 | 0·77 | 10·3 | 0·93 | 711 | 419 |

Solutions A and C were allowed to stand for a period of 24 hours with occasional shaking.

Solution B was boiled for a period of 20 minutes and the precipitate allowed to settle.

It is observed from the table that the residual sulphate is unduly high, accompanied by an unsatisfactory reduction of the fluorine in solution.

It has been shown by the author, that in aqueous solutions, the solubility of the fluorine and sulphate compounds present in superphosphate, suffers a marked reduction, at high concentrations. By adopting this principle, a comparison was effected with the results obtained in Tables I and II, adopting the following procedure.

A highly concentrated solution of superphoshate was prepared, containing 70·5 grams $P_2O_5$ and 391 mgs. $F_2$ per litre. Volumes of this solution yielding the same gross $P_2O_5$ content per litre as in solutions A and B (Table I), were added to litre quantities of distilled water and the same procedure carried out as in the case of solutions A and B, Table I. The results obtained by means of this concentrate are tabulated in Table III.

TABLE III.

| Solution No. | Concentrate c.c. p.lit. | Ca $(OH)_2$ Gr.p.lit. | Initial F. p.p.m. | Residual F. p.p.m. | Initial $SO_4$ p.p.m. | Residual $SO_4$ p.p.m. |
|---|---|---|---|---|---|---|
| A................ | 56 | 4·81 | 21·9 | 0·19 | 213 | Trace. |
| B................ | 56 | 4·81 | 21·9 | 0·02 | 213 | Trace. |

Solution A was allowed to stand for a period of 24 hours with occasional agitation.

Solution B was boiled for a period of 20 minutes and the precipitate allowed to settle.

From Table III it is observed that as a result of the treatment the solute sulphate and fluoride derived from the concentrate suffer an almost complete removal.

Even more marked in comparison are the results obtained by using a concentrated solution of 17 per cent. phosphate, as indicated by the results in Table IV.

The solution adopted contained 62·5 grams $P_2O_5$ and 417 milligrams $F_2$ per litre. This solution is again added to litre quantities of distilled water, yielding equivalent $P_2O_5$ concentrations to solutions A and B (Table II).

TABLE IV.

| Solution No. | Concentrate c.c. p.lit. | Ca $(OH)_2$ Gr.p.lit. | Initial F. p.p.m. | Residual F. p.p.m. | Initial $SO_4$ p.p.m. | Residual $SO_4$ p.p.m. |
|---|---|---|---|---|---|---|
| A............... | 26 | 3·4 | 10·84 | 0·45 | 155 | Trace. |
| B............... | 26 | 3·4 | 10·84 | 0·15 | 155 | Trace. |

Solution A was allowed to stand for a period of 24 hours with occasional agitation.

Solution B was boiled for 20 minutes and the precipitate allowed to settle.

A comparison of the results obtained in Tables II and IV reveals that a phenomenal reduction in the sulphate content of aqueous solutions of 17 per cent. superphosphate (Table IV), can be achieved by simple concentration. This finding proved of immense value in the project of this Institute to ameliorate the ill effects of aphosphorosis in this country by means of superphosphate as a water soluble phosphate.

A comparison of Tables III and IV shows that the two concentrated solutions have the same potential defluorinizing powers, both yielding a treated water containing a trace of sulphate.

The ability of both solid superphosphates and the concentrates to effect the removal of extraneous fluorine was investigated by treating along various lines a water containing 10 p.p.m. $F_2$ as NaF.

Solid double superphosphate was added in varying quantities to litre volumes of distilled water containing 10 p.p.m. F as NaF. The flasks were vigorously agitated to ensure maximal solution of the phosphate. Calcium hydroxide was added until the maximum colour of added phenolphthalein developed.

Solutions A, B and C were precipitated in the cold and then boiled for 20 minutes.

TABLE V.

| Solution No. | Initial F. in Solution p.p.m. | Super-phoshpate. Gr.p.lit. | Ca $(OH)_2$ Gr.p.lit. | Residual F . p.p.m. | Residual $SO_4$ p.p.m. |
|---|---|---|---|---|---|
| A........................ | 10 | 0·5 | 0·5 | 0·95 | Trace. |
| B........................ | 10 | 1·0 | 1·0 | 0·60 | 16 |
| C........................ | 10 | 2·0 | 1·85 | 0·45 | 27 |
| D........................ | 10 | 2·0 | 1·85 | 0·20 | 19 |

Solution D was precipitated at boiling point and subsequently boiled for 20 minutes.

In the case of solutions C and D the fluorine is removed satisfactorily, the residual sulphate being of no significance.

The same procedure as adopted in Table V was carried out using 17 per cent. superphosphate. The results are tabulated in Table VI.

TABLE VI.

| Solution No. | Initial F. in Solution. p.p.m. | Super-phosphate. Gr.p.lit. | Ca $(OH)_2$ Gr.p.lit. | Residual F. p.p.m. | Residual $SO_4$ p.p.m. |
|---|---|---|---|---|---|
| A........................ | 10 | 0·5 | 0·15 | 5·5 | 192 |
| B........................ | 10 | 1·0 | 0·3 | 3·1 | 374 |
| C........................ | 10 | 1·5 | 0·45 | 2·4 | 485 |
| D........................ | 10 | 2·0 | 0·6 | 1·8 | 536 |

Although a definite reduction in NaF concentration is achieved (Table VI), accompanied by a preclusion of the passing into solution of the fluorine contained in the superphosphate, the gross fluorine reduction is incomplete. Treatment by means of solid 19 and 20 per cent. superphosphates also resulted in incomplete removal of added fluorine and a high residual sulphate content of the treated water.

To effect a comparison with the results obtained in Tables V and VI the behaviour of the concentrates towards a water containing 10 p.p.m. F was investigated.

Water containing 10 p.p.m. added fluorine as NaF was saturated with $Ca(OH)_2$, filtered, and treated by means of double superphosphate concentrate as elucidated in Table VII.

TABLE VII.

| Solution No. | Initial F. in Solution. p.p.m. | Concentrate c.c. p.lit. | Added F. p.p.m. | State of Neutralization. | Residual F. p.p.m. | Residual $SO_4$ p.p.m. |
|---|---|---|---|---|---|---|
| A. | 10 | 10·9 | 4·26 | Half Neutralization... | 0·35 | Trace. |
| B. | 10 | 21·8 | 8·52 | Total Neutralization.. | 0·55 | Trace. |
| C. | 10 | 21·8 | 8·56 | Total Neutralization.. | 0·15 | Trace. |
| D. | 10 | 10·9 | 4·26 | Half Neutralization... | 0·70 | Trace. |
| E. | 10 | 10·9 | 4·26 | Half Neutralization... | 0·25 | Trace. |
| F. | 10 | 10·9 | 4·26 | Half Neutralization... | 0·04 | Trace. |

Solution A.—Half neutralization and occasional thorough agitation through a period of 24 hours.

Solution B.—Total neutralization and subjected to the treatment of A.

Solution C.—Total neutralization and boiled for 15 minutes.

Solution D.—Half neutralized and a rapid airstream passed through for 30 minutes.

Solution E.—Half neutralized and boiled for 5 minutes.

Solution F.—Brought to boiling point, slowly half neutralized, boiling continued for 5 minutes.

Solutions A, B and D, precipitated in the cold, yielded precipitates of a gell structure. These precipitates settled very gradually, whereas the boiled suspensions settled readily.

The large volume of concentrate required to neutralize the $Ca(OH)_2$ solution of approximately 0·2 per cent. resulted in the formation of voluminous precipitates. In order to reduce the volume of concentrate, the process of precipitation was reversed, with the following results (Table VIII).

The solutions (Table VIII) were subjected to the following treatment:—

A.—The concentrate is added to the fluorine-containing water (10 p.p.m.) and thoroughly agitated to effect mixing. The $Ca(OH)_2$ added and the suspension boiled for 15 minutes.

B.—The treatment of A.

C.—Concentrate added, shaken, followed by precipitation at boiling point, boiling continued for 15 minutes.

D.—Concentrate added, shaken, $Ca(OH)_2$ added and allowed to stand for 24 hours with occasional agitation.

E.—Concentrate added, shaken, $Ca(OH)_2$ added and boiled for 20 minutes.

F.—Concentrate added and mixture brought to boiling point, $Ca(OH)_2$ added, boiling continued for 10 minutes.

G.—Concentrate added, shaken, $Ca(OH)_2$ added and boiled for 10 minutes.

H.—Concentrate added, shaken, thoroughly agitated for 30 seconds and precipitate allowed to settle.

I.—Concentrate added, shaken, $Ca(OH)_2$ added and allowed to stand for 24 hours with occasional shaking.

J.—Concentrate added, shaken, mixture brought to boiling point, $Ca(OH)_2$ added, boiling continued for a subsequent 10 minutes.

K.—Treatment of D for a period of 72 hours.

TABLE VIII.

| Solution No. | Initial F. in Solution. | Concentrate. c.c. p.lit. | Added F. p.p.m. | $Ca(OH)_2$ Gr.p.lit. | Residual F. p.p.m. | Residual $SO_4$ p.p.m. |
|---|---|---|---|---|---|---|
| A............... | 10 | 1·25 | 0·48 | 0·13 | 1·9 | Trace. |
| B............... | 10 | 2·5 | 0·97 | 0·28 | 1·1 | Trace. |
| C............... | 10 | 2·5 | 0·97 | 0·28 | 0·74 | Trace. |
| D............... | 10 | 5·0 | 1·94 | 0·50 | 0·60 | Trace. |
| E............... | 10 | 5·0 | 1·94 | 0·50 | 0·22 | Trace. |
| F............... | 10 | 6·25 | 2·44 | 0·65 | 0·05 | Trace. |
| G............... | 10 | 6·25 | 2·44 | 0·65 | 0·12 | Trace. |
| H............... | 10 | 10·0 | 3·91 | 0·98 | 1·4 | Trace. |
| I............... | 10 | 10·0 | 3·91 | 0·98 | 0·10 | Trace. |
| J............... | 10 | 12·5 | 4·88 | 1·29 | 0·04 | Trace. |
| K............... | 10 | 12·5 | 4·88 | 1·29 | 0·02 | Trace. |

The 17 per cent. concentrate proved to be equally effective as a defluorizing agent, when the different procedures outlined above are adopted.

The double superphosphate concentrate was evaporated to dryness, and the resultant greyish-brown was pulverized and mixed with the correct equivalent of $Ca(OH)_2$. The incorporation of this product in boiling waters resulted in a very satisfactory removal of extraneous fluorine as elucidated by the results in Table IX.

TABLE IX.

| Solution No. | Initial F. in Solution p.p.m. | Evaporated Concentrate Gr.p.lit. | $Ca(OH)_2$ Gr.p.lit. | Residual F. p.p.m. | Residual $SO_4$ p.p.m. |
|---|---|---|---|---|---|
| A........................ | 10 | 0·25 | 0·3 | 1·6 | Trace. |
| B........................ | 10 | 0·75 | 0·9 | 0·5 | Trace. |
| C........................ | 10 | 1·0 | 1·2 | 0·35 | Trace. |
| D........................ | 10 | 2·0 | 2·4 | 0·08 | Trace. |
| E........................ | 10 | 2·5 | 3·0 | 0·05 | Trace. |

Finally, the suitability of the concentrate method to reduce fluorides from waters very high in total salt content, was investigated. The water in question is one presently adopted in a study of salt water tolerance in sheep, conducted by the Section of Toxicology.

To a litre volume of the water, 5 c.c. of the double superphosphate concentrate was added, resulting in the formation of a slight opacity in the aqueous medium, presumably due to the precipitation of phosphates. $Ca(OH)_2$ in slight excess was added, the mixture thoroughly shaken and boiled for 10 minutes. The results in Table X bear mute testimony as to the improved nature of the treated water.

TABLE X.

| Initial Fixed Residue. p.p.m. | Initial $SO_4$ p.p.m. | Initial $F_2$ p.p.m. | Residual Fixed Residue. p.p.m. | Residual $F_2$ p.p.m. | Residual $SO_4$ p.p.m. |
|---|---|---|---|---|---|
| 16405...................... | 1939 | 6 | 13670 | 0·45 | 1678 |

It is observed that the reduction in sulphate content (Table X) amounts to 261 p.p.m., being approximately equivalent to the sulphate present in the water as $MgSO_4$. This is in line with the finding that the concentrate method of fluorine removal, reduces to a marked degree the sulphates of metals forming insoluble secondary and tertiary phosphates. The sulphates of the alkali metals hardly suffer any reduction.

In an attempt to exploit a possibly cheaper source of calcium phosphate than that of superphosphate origin, the naturally occurring wavelite was considered. This amorphous phosphate of iron and aluminium occurs in vast deposits in the Saldanha Bay environs.

By treating a fluorine containing water with a small quantity of this phosphate ground to an impalpable powder, a colloidal suspension is formed which defies filtering. It has been found possible to break this suspensoid and obtain a treated water containing less than 1 p.p.m. fluorine. Studies in this connection are being continued.

## METHODS OF ANALYSIS.

The treated waters were analysed for their phosphate, sulphate, and fluorine contents. The residual Ca in solution was not taken into consideration as this factor can readily be controlled.

Phosphate was determined colorimetrically by the Fiske and Subbarow method. In all cases except one the treated water contained less than 1 p.p.m. phosphate as P.

Sulphate was determined gravimetrically and residual concentrations of less than 10 p.p.m. are designated by " trace ".

In this investigation it was found necesasry to have a rapid and accurate method for the determination of the fluorine content of the treated waters.

Various colorimetric methods, based on the specific bleaching reaction of the fluoride ion towards the Zirconium lake of certain anthraquinone dyes, are encountered in the literature. The methods of Sanchis (1934) and Elvove (1933) seemed the most promising. According to Scott (1937), 0·1 mgr. fluorine in 100 c.c. is about the limiting amount for a good colour distinction when using the Sanchis modification of the Zirconium alizarin bleach. Apparently this 1 p.p.m. F in water is the limiting concentration to effect a good colour distinction adopting the method of Sanchis.

Treated waters contain less than 1 p.p.m. F. Thus the problem of determining residual fluorine is confined to the determination 0-50 micrograms of fluorine, adopting 50 c.c. volumes of treated water. By modifying the methods of Elvove and Sanchis the author was able to obtain a decided bleach for 2 micrograms per 50 c.c. being equivalent to 0·04 p.p.m. By interpolation adopting a series of standards differing from each other by 5 micrograms of fluorine, the fluorine value of the treated water can be ascertained to the nearest 0·05 p.p.m.

The question as to whether or not fluorine can be completely removed from water, calls for a micro analytcial procedure. The micro titrimetric procedure propounded by Armstrong (1936), together with its numerous modifications did not prove itself entirely satisfactory in the determination of fluorine traces, chiefly due to the difficulty encountered in recognizing the indefinite endpoint.

A micro procedure developed in this laboratory for the determination of fluorine in quantities less than 20 micrograms, was applied in the present investigation in the case of treated waters low in residual fluorine. The findings in all cases were well in line with the results obtained by the modification of the Sanchis and Elvove bleaching methods.*

## SUMMARY.

1. Methods are described whereby the concentration of solute fluorides in water can be reduced to a safe level for human consumption, at a very low cost.

2. The active defluorinizing agent is derived from commercial superphosphate. The sulphate and fluorine compounds present in superphosphates are precluded from passing into solution.

3. By adopting the concentrate method of fluorine removal, it is estimated that 1 Kilogram of double superphosphate can remove from 9 to 10 grams of fluorine from solution. The figure obtained by Klein, Adler and Lindsay (1938), for tri-calcium phosphate in filter beds, amounts to 1·8 grams of fluorine per Kilogram tricalcium phosphate, for ten consecutive cycles.

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* These methods are modifications of the original method of de Boer and Basart (1926).

4. The reaction between the defluorinizing agent and the fluorine in solution is apparently accelerated by heat. Suspensions boiled for 5 to 10 minutes leave a lower residual fluorine content than cold agitations over a 24 hour period. That the process of defluorinization is however a time reaction, culminating in a quantitative adsorption or precipitation of solute fluorides is proved by the fact that prolonged cold agitations result in an almost complete removal of the fluorine in solution.

5. The process of fluorine removal is concomitant with an improvement in the general nature of the water subjected to treatment. A reduction in total solids including a reduction in the concentration of metals forming insoluble secondary and tertiary phosphates, is encountered.

6. The chemical combination in which the fluorine compound is present in the water is of no importance as far as its removal is concerned, NaF, $CaF_2$ and silicofluorides being reduced with equal ease.

7. Insignificant traces of selenium, boron and arsenic were found in the concentrates, adopted in this investigation.

8. The possibility of utilizing the naturally occurring wavelite as defluorinizing agent, is indicated.

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# A Procedure for the Micro Determination of Fluorine.

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THE selective action of the fluoride ion towards the zirconium lake of certain anthraquinone dyes was established by de Boer and Basart (1926).

This principle was adopted in a method of fluorine determination by Willard and Winter (1933), which marked a great forward step in the analysis of fluorine containing materials.

This method has recently been subjected to numerous modifications of which the micro titrimetric procedure of Armstrong (1936) has universally been adopted. Armstrong advocates the use of sodium alizarin alone as indicator, instead of the zirconium alizarin lake, and the alcoholic medium of titration as advocated by Willard and Winter (1933), was passed over in favour of titration in aqueous solutions.

In a recent study on the merits and demerits of the Armstrong modification, McClure (1939) showed that the titration is less sensitive than reported by Armstrong, mainly due to the distressing features of an appreciable blank titration accompanied by an indefinite and uncertain endpoint. The findings of McClure were also experienced in this laboratory.

Dahle, Bonnar and Wichmann (1938), in an excellent study, pointed out that much of the trouble encountered in the titration of small quantities of fluorine can be eliminated by adopting a " back-titration " procedure.

The proposed method of Dahle *et al*, though based on sound principles, did not prove itself entirely satisfactory in the hands of the author due to the gradual change of colour in the zero tube during back titration, until a colour-match with the incipient pink of the sample tube is attained.

The procedure advocated in this study is essentially a modification of the " back titration " method of Dahle *et al* (1938), an additional indicator being introduced with advantage and actual titration being done away with, thus avoiding the necessity of a correction in final volumes before a colour match can be effected. The immediate advantage being that all determinations are executed under absolutely uniform conditions, the final matching being done with fixed colours.

The method advocated in this study is not concerned with the determination of fluorine quantities in excess of 0·1 milligram.

## METHOD.

### VOLATILIZATION OF THE FLUORINE.

To effect the volatilization of the fluorine from the sample subjected to analyses, an all glass steam distillation unit was adopted, consisting essentially of a 50 ml. round bottomed flask fitted with a Claissen adaptor. The thermometer and capillary reaching to within 3 mm. of the bottom of the flask, pass through the straight arm of the Claissen head, the side arm of the latter being fitted with a condenser-adaptor unit. The adaptor reaches well down into the receiving flask.

The sample, containing not more than 0·1 mg. fluorine, is introduced into the distillation flask, about 0·05 grm. silica and three glass beads are added. The apparatus is assembled and through the capillary is introduced a mixture of 5 ml. 60 per cent. Perchloric acid and 10 ml. doubly distilled water.

The distillation flask is rested on a metal plate with a hole drilled in the centre so as to fit the flask perfectly, the liquid-glass junction not being exposed to the naked flame.

The charge in the distillation flask is brought to its initial boiling point and boiling continued until a temperature of 130° C. is reached. The steam distillation unit is now brought into operation, and by occasionally adjusting the flame the temperature is readily controlled at a constant 130° C. Any fluctuations in the temperature should be avoided. Any trouble encountered with bumping before the distillation temperature of 130° C. is reached, may readily be avoided by passing a slow stream of nitrogen through the unit.

Distillation is continued until 200 ml. of distillate has collected. In the case of ashed samples rich in phosphate (pyrophosphate), it is imperative that a double perchloric acid distillation be executed to avoid the interference brought about by the presence of the phosphate ion in the distillate. The danger attached to the perchloric acid volatilization of fluorine from ashed samples still containing traces of organic material may be overcome by adopting sulphuric acid (6 ml. $H_2SO_4$ S.G. 1·84, + 10 ml. water) at 140° C. in the first distillation and subsequently redistilling the evaporated alkaline distillate by means of perchloric acid as described.

If the total chlorine content of the sample is in excess of 15 mg., solid silver sulphate is added to the charge in an approximate equivalence to the chlorine concentration, and the distillation carried out as described. If the chlorine containing sample, on combustion, yields a relatively large volume of ash, the addition of silver sulphate may cause the charge to be unduly restive during distillation.

Under these circumstances it is advisable to eliminate chlorides by the addition of solid silver sulphate to the evaporated alkaline distillate and execute a second distillation

## REAGENTS.

*Indicator.*—0·01 per cent. sodium alizarin sulphonate (Alizarin Red S) in a saturated aqueous solution of 1, 2, 5, 8 Tetra-oxy-anthraquinone (Alizarin Bordeaux).

*Standard Fluoride Solution.*

(*a*) 1 ml. = 0·00025 mg. of fluorine.

(*b*) 1 ml. = 0.0005 mg. of fluorine.

These solutions are obtained by dilution from a stock containing 1·00 gram of fluorine as sodium fluoride per litre.

*Thorium Nitrate Solution.*

Dissolve ±0·1 gram of $Th(NO_3)_4 \cdot 12H_2O$ per litre of water.

*Sodium Hydroxide Standard Solution.*

0·01 N Solution.

*Hydrochloric Acid Standard Solution.*

0·05 N Solution, standardized against the sodium hydroxide solution, using sodium alizarin sulphonate as indicator.

## APPARATUS.

Standard Nessler tubes of 50 ml. capacity. The tubes should be illuminated from the bottom by a uniformly white surface receiving its light from the blue sky.

## PROCEDURE OF DETERMINATION.

(1) The total acidity of a 40 ml. aliquot of the distillate is established (titration with 0·01 N NaOH against sodium alizarin sulphonate as indicator).

(2) To a second 40 ml. aliquot of the distillate is added 1 ml. of indicator and 0·05 N hydrochloric acid in quantiy such as to make the total acidity of the sample equivalent to 2 ml. 0·05 N acid.

(3) The thorium solution is now run into (2) with continual agitation. The colour change is from light greenish-yellow to incipient lilac pink. The titration (from a burette graduated in 0·02 ml. is stopped when a decidedly permanent pink colour is obtained. The colour intensity (pink) is regulated according to what the operator considers a suitable colour for matching.

(4) To establish the approximate magnitude of the fluorine in the unknown, three standard tubes are prepared containing respectively 5, 10 and 15 micrograms of fluorine per 40 ml. volumes. 1 ml. indicator is added to each and exactly 2 ml. 0·05 N hydrochloric acid (the standard tubes made up by doubly distilled water are neutral as indicated by a very faint orange-pink colour of the indicator). Into each tube is now run exactly the same volume of thorium solution as used in (3).

By a colour match the approximate fluorine content of the unknown is established to the nearest 2·5 micrograms. Supposing it to be approximately 7·5 micrograms, then 10 tubes differing from each other by 0·25 micrograms of fluorine and covering the possible range of the fluorine content of the sample, are prepared. Again, the standard tubes are subjected to the same treatment as the unknown i.e. add 1 ml. of indicator, the colour after mixing should be a faint orange-pink (neutral). Exactly 2 ml. 0·05 N hydrocloric acid is introduced and again thoroughly mixed, followed by the introduction of the same volume of thorium solution as necessitates the production of a definitely pink colour in the unknown. Standard tubes and the unknown are thus compared at equal volumes, constant pH and identical concentration.

By interpolation the fluorine content of the sample tube may thus be ascertained to the nearest 0·13 micrograms of fluorine.

## PROCEDURE OF DETERMINATION ON THE TOTAL DISTILLATE.

The taking of aliquot samples of the distillate has its distinct advantages, such as avoiding the necessity of evaporation and consequently the introduction of the alkali ion. Furthermore a higher total acidity of the distillate is permissible. The errors caused in micro determination of fluorine as a result of the introduction of the sodium ion and the subsequent evaporation of the alkaline distillate in glass, will be discussed elsewhere in this paper.

In cases where the total fluorine content of the sample pending analysis is less than 20 micrograms, it is naturally advisable to execute the determination on the total distillate.

The volatilization of the fluorine, is carried out as described, in all cases effecting a quantitative removal of chlorides, the total acidity of the distillate being kept as low as possible.

The free acid in the distillate is neutralized by means of 0·01 N sodium hydroxide against a minimum of phenolphthalein as indicator. During evaporation the pink of the phenolphthalein must be kept decidedly visible. The total volume of sodium hydroxide added should not be in excess of 5·0 ml. 0·01 N. Evaporation is to be executed in platinum, the exaporation unit being suitably shielded against air contamination. If platinum is not available, porcelain should be preferred. The distillate is evaporated to a volume of approximately 20 ml. and transferred to a Nessler tube, keeping the volume at about 30 ml. Hydrochloric acid 0·05 N is added dropwise until the pink of the phenolphthalein is just expelled. One c.c. indicator is added and again 0·05 N hydrochloric acid dropwise until the last faint pink almost changes to yellow. The volume is made up to 41 ml. and exactly 2 ml. 0·05 hydrochloric acid introduced. To approximately 30 ml. volumes of the standard in the Nessler tubes are added the exact volumes of 0·01 N sodium hydroxide and phenolphthalein used in the neutralization of the distillate. The pink of the phenolphthalein is just destroyed by the dropwise addition of 0·05 N hydrochloric acid, 1 ml. of the indicator is added and the pink colour almost destroyed, the volume is made up to 41 ml. followed by the addition of exactly 2 ml. 0·05 N hydrochloric acid.

The standards and the sample have been subjected to the same treatment and the determination is carried out as described.

## CHOICE OF INDICATOR AND INDICATOR REQUIREMENTS.

Armstrong (1936) modified the Willard and Winter (1933) procedure by employing sodium alizarin sulphonate alone as indicator to effect the titration of minute quantities of fluorine in aqueous medium. The author observed that by the introduction of a trace of 1, 2, 5, 8 tetraoxyanthraquinone together with sodium alizarin sulphonate, the sensitivity of the indicator changes produced by fluorine traces, is enhanced.

Alizarin Bordeaux is practically insoluble in doubly distilled, $CO_2$ free water. A saturated solution (aqueous) is prepared by agitating a suspension of Alizarin Bordeaux in doubly distilled water for several days, care being subsequently executed to eliminate the last traces of suspensoid by filtration.

It has long been recognized that the amount of indicator used in the titrimetric determination of fluorine has a marked influence on the results obtained.

The method of adding the indicator in a specified number of drops , as advocated by Armstrong (1936), Willard and Winter (1933), etc., has been passed over in favour of adding the indicator in exact measured quantities (Dahle *et al* 1938).

The effect of varying amounts of indicator on the colour change produced by the addition of thorium solution, in the absence of fluorine and secondly the sensitivity of the coloured lake towards traces of added fluorine, was invesigated (Table I).

TABLE I.

*The Significance of Indicator Concentration.*

| Tube No. | Indicator Concentration. Per cent. | Thorium Solution. First Pink. ml. | Thorium Solution. Definite Pink. ml. | Colour. | Sensitivity to 0·25 Micrograms Fluorine. |
|---|---|---|---|---|---|
| 1 | $1{\cdot}25 \times 10^{-4}$..... | 0·40 | 0·50 | Pale Pink......... | Fairly Sharp. |
| 2 | $2{\cdot}50 \times 10^{-4}$..... | 0·42 | 0·55 | Lilac Pink........ | Sharp. |
| 3 | $3{\cdot}75 \times 10^{-4}$..... | 0·52 | 0·62 | Lilac Pink........ | Sharp. |
| 4 | $5{\cdot}00 \times 10^{-4}$..... | 0·64 | 0·82 | Incipient brownish pink | Fairly Sharp. |
| 5 | $6{\cdot}25 \times 10^{-4}$..... | 0·73 | 0·92 | Brownish tint, masking the sensitivity of the bleach. | Poor. |
| 6 | $7{\cdot}50 \times 10^{-4}$..... | 0·86 | 1·04 | | |
| 7 | $8{\cdot}75 \times 10^{-4}$..... | 0·90 | 1·12 | | |
| 8 | $1{\cdot}00 \times 10^{-3}$..... | 0·92 | 1·23 | | |
| 9 | $1{\cdot}13 \times 10^{-3}$..... | 0·98 | 1·28 | | |
| 10 | $1{\cdot}25 \times 10^{-3}$..... | 1·12 | 1·40 | | |

In the absence of fluorine, the volume of thorium solution necessary to produce the pink lake is markedly increased concomitant with an increase in indicator concentration (Table I).

An indicator concentration in excess of $3 \cdot 75 \times 10^{-4}$ per cent. is accompanied by the formation of a brownish tint in the lake, masking the sensitivity of the indicator bleach towards the fluoride ion. On the other hand, the final colour in tube No. I is very pale for a good colour match. The optimum indicator concentration appears to be somewhere between $(2 \cdot 50 - 3 \cdot 75) \times 10^{-4}$ per cent. The author found an indicator concentration of $2 \cdot 50 \times 10^{-4}$ per cent., i.e., 1·0 ml. of a 0·01 per cent. solution, excellent when narrow bore Nessler tubes are employed in the final colour match. Fellenberg (1937) in his titrimetric procedure, adopts an identical indicator concentration, viz 0·05 ml. of 0·05 per cent. solution per 10 ml. volumes. This is also the indicator concentration adopted by Dahle *et al* (1938) in their "Back Titration" procedure. In the procedure of Hoskins and Ferris (1936) an indicator concentration of $4 \times 10^{-5}$ per cent. is advocated.

## The Effect of Indicator Concentration on the Titer of the Thorium Nitrate Solution.

The effect on the titer of the thorium solution as a result of varying the indicator concentration, was established, adopting the following procedure. Pairs of tubes at identical volumes, indicator concentration and pH, were taken. The first tube belongs to a zero (blank) series and the second to a fluorine series containing 10, 15 and 20 micrograms of fluorine respectively. The indicator concentration is varied between pairs of paired tubes (Table II), keeping volumes (43 ml.), fluorine content (10, 15, 20Y) and pH (2·74) a constant. The thorium solution is run into the fluoride tubes until the first appearance of a definite pink. The zero tube is then titrated to the same colour. The difference in the burette readings gives the thorium nitrate equivalence per 10, 15 and 20 micrograms of fluorine, as elucidated in Table II.

At a constant fluorine concentration, a decided increase is observed (Table II), in the titer of the thorium solution, expressed as micrograms fluorine per ml., with a corresponding. increase in indicator concentration.

At a constant indicator concentration, an increase in the fluorine concentration from 10 to 20 micrograms per 40 ml. is accompanied by a correspondingly slight increase in the titer of the thorium solution (Table II).

The importance of executing determinations at a constant indicator concentration, is emphasized by the results contained in Table II.

## The Significance of the pH in the Determination.

It has long been recognized that in the titration of the fluoride ion by means of thorium nitrate, the pH of the titration medium has a significant bearing on the utlimate results. It is only recently however that the importance has been stressed of exercising a definite control of the pH during titration.

### TABLE II.

*The Effect of Indicator Concentration on the Titer of the Thorium Solution.*

| Tube No. | Indicator Concentration. Per cent. | Fluorine added Micrograms. | THORIUM SOLUTION. | | Titer Micrograms. p. ml. |
|---|---|---|---|---|---|
| | | | F. Tubes. ml. | Blanks. ml. | |
| 1 | $1{\cdot}25 \times 10^{-4}$ | 10 | 2·29 | — | — |
| 1a | $1{\cdot}25 \times 10^{-4}$ | 0 | — | 0·42 | 5·30 |
| 2 | $2{\cdot}50 \times 10^{-4}$ | 10 | 2·30 | — | — |
| 2a | $2{\cdot}50 \times 10^{-4}$ | 0 | — | 0·58 | 5·80 |
| 3 | $3{\cdot}75 \times 10^{-4}$ | 10 | 2·28 | — | — |
| 3a | $3{\cdot}75 \times 10^{-4}$ | 0 | — | 0·69 | 6·30 |
| 4 | $5{\cdot}00 \times 10^{-4}$ | 10 | 2·16 | — | — |
| 4a | $5{\cdot}00 \times 10^{-4}$ | 0 | — | 0·75 | 7·10 |
| 5 | $6{\cdot}25 \times 10^{-4}$ | 10 | 2·20 | — | — |
| 5a | $6{\cdot}25 \times 10^{-4}$ | 0 | — | 0·92 | 7·80 |
| 1 | $1{\cdot}25 \times 10^{-4}$ | 15 | 3·02 | — | — |
| 1a | $1{\cdot}25 \times 10^{-4}$ | 0 | — | 0·42 | 5·80 |
| 2 | $2{\cdot}50 \times 10^{-4}$ | 15 | 3·00 | — | — |
| 2a | $2{\cdot}50 \times 10^{-4}$ | 0 | — | 0·54 | 6·10 |
| 3 | $3{\cdot}75 \times 10^{-4}$ | 15 | 3·00 | — | — |
| 3a | $3{\cdot}75 \times 10^{-4}$ | 0 | — | 0·70 | 6·50 |
| 4 | $5{\cdot}00 \times 10^{-4}$ | 15 | 2·74 | — | — |
| 4a | $5{\cdot}00 \times 10^{-4}$ | 0 | — | 0·84 | 7·90 |
| 5 | $6{\cdot}25 \times 10^{-4}$ | 15 | 2·74 | — | — |
| 5a | $6{\cdot}25 \times 10^{-4}$ | 0 | — | 0·92 | 8·20 |
| 1 | $1{\cdot}25 \times 10^{-4}$ | 20 | 3·88 | — | — |
| 1a | $1{\cdot}25 \times 10^{-4}$ | 0 | — | 0·42 | 5·80 |
| 2 | $2{\cdot}50 \times 10^{-4}$ | 20 | 3·70 | — | — |
| 2a | $2{\cdot}50 \times 10^{-4}$ | 0 | — | 0·56 | 6·00 |
| 3 | $3.75 \times 10^{-4}$ | 20 | 3·70 | — | — |
| 3a | $3{\cdot}75 \times 10^{-4}$ | 0 | — | 0·71 | 6·70 |
| 4 | $5{\cdot}00 \times 10^{-4}$ | 20 | 3·31 | — | — |
| 4a | $5{\cdot}00 \times 10^{-4}$ | 0 | — | 0·78 | 7·90 |
| 5 | $6{\cdot}25 \times 10^{-4}$ | 20 | 3·30 | — | — |
| 5a | $6{\cdot}25 \times 10^{-4}$ | 0 | — | 0·95 | 8·50 |

Rowley and Churchill (1937) state that in the titration of fluorine quantities ranging from 0·5 to 10 mg. a pH range of 2·9 to 3·1 appears to be an optimum. These authors further state that in the titration of minute quantities of fluorine the titer is extremely sensitive towards any change in pH, the optimum being unknown.

In the literature no attention is directed to the actual difference in the titration of fluorides and silico-fluorides, by means of thorium nitrate.

1. $Th(NO_3)_4 + 4NaF = ThF_4 + 4NaNO_3$.
2. $3Th(NO_3)_4 + 2H_2SiF_6 + 4H_2O = 3ThF_4 + 12HNO_3 + 2SiO_2$.

In practice a thorium nitrate solution is standardized according to equation 1 and this standardized solution is subsequently used to establish the fluorine content of the distillate according to equation 2. It is at once evident that equations 1 and 2 represent two entirely different reactions.

According to the postulate of Willard and Winter (1933) the fluorine compound finding its way into the distillate, is hydrofluosilicic acid. During the subsequent titration nitric acid is formed at the expense of the disappearance of hydrofluosilicic acid from the solution (Equation 2).

In the determination of 20 micrograms of fluorine, 0·007 ml. 0·05 N $H_2SiF_6$ disappears concomitant with the formation of 0·021 ml. 0·05 N $HNO_3$. Thus in the determination of 20 micrograms of fluorine the acidity gain in the sample tube is equivalent to 0·014 ml. 0·05 N acid, whereas the acidity of the standard tubes remains constant (cf. Equation 1). The choice of a suitable pH for the determination is thus confined to a range where 0·014 ml. 0·05 acid has no effect on the pH. Dahle *et al* (1938) consider pH 3 as the upper limit and pH 2·5 as the lower limit " with a pH 2·75 as good a practical choice as any ", for the determination of 50 micrograms of fluorine.

Bearing in mind the fact that acid is liberated during titration, the lower limit of Dahle would be preferable, as the change in pH produced by added acid is much less at pH 2·5 than that produced by the same amount of acid at pH 3·0. At a pH of 2·5, i.e., approximately 3 ml. 0·05 N HCl per 40 ml. a reduction in the sensitivity of the bleach is observed. In this study the choice of Dahle *et al* (1938), i.e., a pH of 2·75 was adopted, and the divergence produced by a change of pH above and below 2·75 was investigated in the case of added quantities of fluorine ranging from one to ten micrograms.

The standard tubes were kept constant at a pH 2·74, final volumes before thorium addition being 43 ml.

In a second series of tubes, with a respective fluorine content of 1, 5 and 10 micrograms of fluorine, a pH range of 2 to 3 was effected by the addition of 0·05 N HCl as elucidated in Table III. Final volumes before thorium addition are controlled at 43 ml.

The phenomenal effect produced by pH variation in the range 2 to 3 (Table III) emphasizes the importance of exercising a definite control on the pH of the standard and the unknown.

It is observed from Table III that the percentage error is decreased with a corresponding increase in the fluorine content from 1 to 10 micrograms. Dahle *et al* (1938) state that an increase in the fluorine content from 2 to 50 micrograms is accompanied by an increase in error, caused by variations in pH.

At the pH (2·74), adopted in this study, the formation of 0·014 ml. 0·05 N acid during titration, has no effect on the pH and the recovery of added fluorine. Thus, apparently, in micro work, the use of sodium fluoride in conjuction with the determination of silicofluorides, introduces no errors, whereas in macro work this phase of the determination needs careful attention.

## TABLE III.

*The Effect of pH on the Recovery of Added Fluorine.*

| Tube No. | 0·05 N. HCl Test Tubes. ml. | pH.* | Added F Micrograms. | 0·05 N. HCl Standards. ml. | pH.* | F Found Micrograms. | F Error Micrograms. |
|---|---|---|---|---|---|---|---|
| 1a | 0·8 | — | 1 | 2 | — | 0·0 | 1·0 |
| 1b | 0·8 | 3·09 | 5 | 2 | 2·74 | 2·0 | 3·0 |
| 1c | 0·8 | — | 10 | 2 | — | 5·2 | 4·8 |
| 2a | 1·0 | — | 1 | 2 | — | 0·0 | 1·0 |
| 2b | 1·0 | 3·03 | 5 | 2 | 2·74 | 2·4 | 2·6 |
| 2c | 1·0 | — | 10 | 2 | — | 5·5 | 4·5 |
| 3a | 1·2 | — | 1 | 2 | — | 0·2 | 0·8 |
| 3b | 1·2 | 2·94 | 5 | 2 | 2·74 | 2·9 | 2·1 |
| 3c | 1·2 | — | 10 | 2 | — | 6·8 | 3·2 |
| 4a | 1·4 | — | 1 | 2 | — | 0·3 | 0·7 |
| 4b | 1·4 | 2·89 | 5 | 2 | 2·74 | 3·5 | 1·5 |
| 4c | 1·4 | — | 10 | 2 | — | 7·2 | 2·8 |
| 5a | 1·6 | — | 1 | 2 | — | 0·5 | 0·5 |
| 5b | 1·6 | 2·83 | 5 | 2 | 2·74 | 4·4 | 0·6 |
| 5c | 1·6 | — | 10 | 2 | — | 9·1 | 0·9 |
| 6a | 1·8 | — | 1 | 2 | — | 0·8 | 0·2 |
| 6b | 1·8 | 2·79 | 5 | 2 | 2·74 | 4·8 | 0·2 |
| 6c | 1·8 | — | 10 | 2 | — | 9·7 | 0·3 |
| 7a | 2·0 | — | 1 | 2 | — | 1·0 | 0·0 |
| 7b | 2·0 | 2·74 | 5 | 2 | 2·74 | 2·0 | 0·0 |
| 7c | 2·0 | — | 10 | 2 | — | 10·0 | 0·0 |
| 8a | 2·2 | — | 1 | 2 | — | 1·0 | 0·0 |
| 8b | 2·2 | 2·70 | 5 | 2 | 2·74 | 4·8 | 0·2 |
| 8c | 2·2 | — | 10 | 2 | — | 10·2 | 0·2 |
| 9a | 2·4 | — | 1 | 2 | — | 1·2 | 0·2 |
| 9b | 2·4 | 2·66 | 5 | 2 | 2·74 | 5·5 | 0·5 |
| 9c | 2·4 | — | 10 | 2 | — | 10·6 | 0·6 |
| 10a | 2·6 | — | 1 | 2 | — | 1·3 | 0·3 |
| 10b | 2·6 | 2·63 | 5 | 2 | 2·74 | 5·8 | 0·8 |
| 10c | 2·6 | — | 10 | 2 | — | 11·1 | 1·1 |
| 11a | 5·0 | — | 1 | 2 | — | 3·2 | 2·2 |
| 11b | 5·0 | 2·33 | 5 | 2 | 2·74 | 9·4 | 4·4 |
| 11c | 5·0 | — | 10 | 2 | — | 16·8 | 6·8 |
| 12a | 10·0 | — | 1 | 2 | — | 5·5 | 4·5 |
| 12b | 10·0 | 2·02 | 5 | 2 | 2·74 | 19·8 | 14·8 |
| 12c | 10·0 | — | 10 | 2 | — | 36·5 | 26·5 |

* Measured by Dr. A. G. Polsen, Section of Virus Diseases.

In this connection the use of a buffer has been introduced by Hoskins and Ferris (1936), who found a pH of 3·5 the most satisfactory for the micro and semi-micro determination of fluorine. In order to obtain this pH at half neutralization, where buffering power is maximum, the buffer acid must have a paK of the same magnitude. Monochloracetic acid has a paK of 2·8 in water, passing to 3·55 in 48 per cent. alcohol (Hoskins, 1938), being also the pH at half neutralization.

The use of the Hoskins-Ferris buffer was omitted in the present study, as the use of a buffer at a pH of 2·74 is unnecessary when 20 micrograms of fluorine are determined. Furthermore, the introduction of this buffer definitely affects the sensitivity of the bleach.

## THE EFFECT OF PH VARIATIONS ON THE TITER OF THE THORIUM SOLUTION.

The effect produced on the titer of the thorium solution as a result of varying the acidity was established by carrying out the following procedure. A series of paired tubes was prepared, containing 1 and 2, 2 and 4, 5 and 10, 10 and 20. 20 and 40 micrograms of fluorine respectively, the indicator concentration a constant at $2 \cdot 5 \times 10^{-4}$ per cent. The series as a whole was then subjected to differences in acidity as elucidated in Table IV. Final volumes prior to the introduction of thorium solution were controlled at 43 ml. The thorium nitrate equivalence of the fluorine difference between the paired tubes was established and calculated to unity to arrive at the titer of the thoruim solution (Table IV).

### TABLE IV.

*The Effect of Variations in pH on the Titer of the Thorium Solution.*

| Tube No. | 0·05 N. HCl ml. | pH. | Series A Micrograms F. | Series B Micrograms F. | THORIUM SOLUTION. | | Titer Micrograms pml. |
|---|---|---|---|---|---|---|---|
| | | | | | Series A ml. | Series B ml. | |
| 1 | — | — | 1 | — | 0·59 | — | — |
| 1a | — | — | — | 2 | — | 0·72 | 7·4 |
| 2 | — | — | 2 | — | 0·73 | — | — |
| 2a | — | — | — | 4 | — | 1·00 | 7·4 |
| 3 | 1·00 | 3·03 | 5 | — | 1·12 | — | — |
| 3a | — | — | — | 10 | — | 1·78 | 7·6 |
| 4 | — | — | 10 | — | 1·72 | — | — |
| 4a | — | — | — | 20 | — | 2·98 | 7·9 |
| 5 | — | — | 20 | — | 2·93 | — | — |
| 5a | — | — | — | 40 | — | 5·39 | 8·1 |
| 1 | — | — | 1 | — | 0·66 | — | — |
| 1a | — | — | — | 2 | — | 0·82 | 6·3 |
| 2 | — | — | 2 | — | 0·82 | — | — |
| 2a | — | — | — | 4 | — | 1·14 | 6·4 |
| 3 | 1·40 | 2·89 | 5 | — | 1·25 | — | — |
| 3a | — | — | — | 10 | — | 2·01 | 6·6 |
| 4 | — | — | 10 | — | 2·08 | — | — |
| 4a | — | — | — | 20 | — | 3·66 | 6·3 |
| 5 | — | — | 20 | — | 3·36 | — | — |
| 5a | — | — | — | 40 | — | 6·22 | 6·9 |
| 1 | — | — | 1 | — | 0·68 | — | — |
| 1a | — | — | — | 2 | — | 0·86 | 5·6 |
| 2 | — | — | 2 | — | 0·88 | — | — |
| 2a | — | — | — | 4 | — | 1·26 | 5·3 |
| 3 | 1·80 | 2·79 | 5 | — | 1·41 | — | — |
| 3a | — | — | — | 10 | — | 2·32 | 5·5 |
| 4 | — | — | 10 | — | 2·19 | — | — |
| 4a | — | — | — | 20 | — | 3·88 | 5·9 |
| 5 | — | — | 20 | — | 3·38 | — | — |
| 5a | — | — | — | 40 | — | 6·46 | 6·5 |

TABLE IV—*continued.*

| Tube No. | 0·05 N. HCl ml. | pH. | Series A Micrograms F. | Series B Micrograms F. | THORIUM SOLUTION. | | Titer Micrograms pml. |
|---|---|---|---|---|---|---|---|
| | | | | | Series A ml. | Series B ml. | |
| 1 | — | — | 1 | — | 0·69 | — | — |
| 1a | — | — | — | 2 | — | 0·88 | 5·3 |
| 2 | — | — | 2 | — | 0·89 | — | — |
| 2a | — | — | — | 4 | — | 1·28 | 5·1 |
| 3 | 2·00 | 2·74 | 5 | — | 1·42 | — | — |
| 3a | — | — | — | 10 | — | 2·34 | 5·4 |
| 4 | — | — | 10 | — | 2·26 | — | — |
| 4a | — | — | — | 20 | — | 4·02 | 5·7 |
| 5 | — | — | 20 | — | 3·81 | — | — |
| 5a | — | — | — | 40 | — | 7·12 | 6·0 |
| 1 | — | — | 1 | — | 0·75 | — | — |
| 1a | — | — | — | 2 | — | 1·00 | 4·0 |
| 2 | — | — | 2 | — | 0·98 | — | — |
| 2a | — | — | — | 4 | — | 1·46 | 4·2 |
| 3 | 2·60 | 2·66 | 5 | — | 1·58 | — | — |
| 3a | — | — | — | 10 | — | 2·66 | 4·6 |
| 4 | — | — | 10 | — | 2·48 | — | — |
| 4a | — | — | — | 20 | — | 4·46 | 5·1 |
| 5 | — | — | 20 | — | 4·62 | — | — |
| 5a | — | — | — | 40 | — | 8·72 | 5·6 |
| 1 | — | — | 1 | — | 1·04 | — | — |
| 1a | — | — | — | 2 | — | 1·38 | 2·9 |
| 2 | — | — | 2 | — | 1·30 | — | — |
| 2a | — | — | — | 4 | — | 1·91 | 3·3 |
| 3 | 5·00 | 2·33 | 5 | — | 2·00 | — | — |
| 3a | — | — | — | 10 | — | 3·27 | 3·9 |
| 4 | — | — | 10 | — | 3·08 | — | — |
| 4a | — | — | — | 20 | — | 5·46 | 4·2 |
| 5 | — | — | 20 | — | 4·88 | — | — |
| 5a | — | — | — | 40 | — | 9·06 | 4·8 |
| 1 | — | — | 1 | — | 1·70 | — | — |
| 1a | — | — | — | 2 | — | 2·07 | 2·7 |
| 2 | — | — | 2 | — | 2·12 | — | — |
| 2a | — | — | — | 4 | — | 2·74 | 3·2 |
| 3 | 10·00 | 2·02 | 5 | — | 3·16 | — | — |
| 3a | — | — | — | 10 | — | 4·52 | 3·7 |
| 4 | — | — | 10 | — | 4·30 | — | — |
| 4a | — | — | — | 20 | — | 6·90 | 3·8 |
| 5 | — | — | 20 | — | 6·32 | — | — |
| 5a | — | — | — | 40 | — | 10·82 | 4·4 |

It is observed (Table IV) that the titer of the thorium solution is markedly decreased relative to a decreasing pH in the range 3 to 2, using 1 to 20 micrograms of fluorine for the titer determination. At a constant pH, a tendency towards a slight increase in titer is observed, when the fluorine-concentration adopted for the titer determination is increased from 1 to 20 micrograms. In the pH range 2·66 to 2·02 this increase in titer relative to an increase in fluorine concentration, becomes more pronounced than in the pH range 3·03 to 2·74.

Armstrong (1936) states that at a constant pH, the titer of a thorium nitrate solution is independent of the amount of fluorine used for the titer determination, if titration is executed in aqueous medium, but does not hold true for titrations in alcoholic medium. The work of Dahle *et al* (1938), corroborates the findings of Armstrong.

## THE CHOICE OF A FLUORIDE STANDARD.

The difficulty encountered in procuring a pure fluoride product for adoption as standard, has been reported by various workers.

In this laboratory, analytical samples of sodium fluoride were found to have a percentage purity as low as 96 per cent. (conversion to sulphate, precipitation as lead chloro-fluoride and by comparing its thorium nitrate titer with that of specially prepared fluorine compounds).

Hoffmann and Lundell (1929), modified the method used by McAdam and Smith (1912) in atomic weight work, for the preparation of a high purity sodium fluoride.

The author prepared a sodium fluoride of satisfactory purity, adopting the method of Reynolds and Hill (1939), The purity of this product was checked against a precipitated strontium fluoride prepared from a high purity strontium chloride.

Analyses of these products by precipitation as lead chlorofluoride (P. Ed. Winkler, 1938), and by comparing their thorium nitrate titers, gave a purity of 99·2 per cent.

## THE CHOICE OF A VOLATILIZING ACID.

The three non-volatile acids available for the volatilization of fluorine as hydrofluosilicic acid, are sulphuric, phosphoric and perchloric acids.

The distillation of phosphatic materials with phosphoric acid to effect the volatilization of the fluorine, has frequently been frowned upon, on account of the fact that orthophosphate is invariably present in the distillates, causing plus errors in the titration. This acid is undoubtedly of value to effect the separation of fluorine from ashed samples still containing an appreciable amount of organic material. In the present study this acid has not been considered.

Sulphuric acid was recommended by Willard and Winter (1933) and has subsequently been adopted by various workers in both micro and semi-micro procedures, the advantage of sulphuric acid again being that it may be used in the presence of organic material.

Perchloric acid was found by Willard and Winter (1933) to be an excellent agent to effect the volatilization of fluorine as the fluosilicic acid. The solubility of perchlorates makes this acid especially suitable where large amounts of ash have to be distilled. A certain amount of danger is attached to the use of this acid in the presence of organic material.

Both sulphuric and perchloric acids have repeatedly been demonstrated to effect a quantitative volatilization of fluorine. To conclude thus as to their respective merits and demerits, it is necessary to establish the errors caused by the presence of these acids in the distillate, subjected to determination.

Sulphuric and perchloric acids find their way into the distillates, being either carried over as a spray, or due to a partial volatilization. The amount of acid present in blank distillates depends upon the size of the distillation flask, temperature of distillation, and as Dahle (1938) pointed out, due to an overheating of the flask above the liquid junction.

The presence, in the sample subjected to distillation, of certain salts especially chlorides, naturally gives rise to a high acidity of the distillate.

The effect produced by the presence of sulphuric, perchloric and hydrochloric acids in the distillate, both blank and fluorine-bearing, was investigated.

The sulphuric acid used is a Mercks reagent (S.G. I. 84) and was previously heated in a glycerine bath at 180° C. for one hour to expel all traces of volatile sulphur compounds which may be formed in the acid due to the presence of chloride traces.

Distillate volumes of 200 ml. were collected from five lots of this acid, at 140° C. A mixture of 6 ml. concentrated acid and 10 ml. water was adopted. Initial boiling point being 125° C.

The assembled apparatus was freed from all $CO_2$ by passing a current of nitrogen through the unit, and using a $CO_2$ free water for the generation of steam. The distillate was guarded against a possible $CO_2$ contamination. Under these conditions the total acidity of the distillate may be ascribed to the presence of free sulphuric acid. The values obtained for acidities and apparent fluorine content of blank sulphuric acid distillates, are shown in Table V.

TABLE V.

*The Acidity, Sulphate and apparent Fluorine Content of Blank Sulphuric Acid Distillates collected at 140° C.*

| Distilate No. | 0·01 N. NaOH ml. | $H_2SO_4$ Concentration Grams. | 0·05 N. HCl ml. | Fluorine Blank Micrograms. |
|---|---|---|---|---|
| 1.................. | 0·28 | $0{\cdot}137 \times 10^{-3}$......... | 1·95 | 0·60 |
| 2.................. | 0·30 | $0{\cdot}147 \times 10^{-3}$......... | 1·94 | 0·70 |
| 3.................. | 0·31 | $0{\cdot}152 \times 10^{-3}$......... | 1·94 | 0·60 |
| 4.................. | 0·29 | $0{\cdot}143 \times 10^{-3}$......... | 1·95 | 0·50 |
| 5.................. | 0·34 | $0{\cdot}166 \times 10^{-3}$......... | 1·93 | 0·70 |

The near constancy of the total acidity and apparent fluorine value of sulphuric acid distillates, collected under uniform conditions, is striking (Table V).

The bleaching effect of the blank distillate towards the alizarin compound is apparently due to some substance other than fluorine since the constancy of this bleach is reduced by added fluorine (Table VI). Fluorine in a range of 2 to 10 micrograms was added to a mixture of the distillates 1, 2, 3, 4 and 5 (Table V) and the recovery of added fluorine established by matched standard tubes (Table VI).

TABLE VI.

*The Effect of Added Fluorine on the Blank Bleach.*

| Sample No. | 0·01 N. NaOH c.c. | $H_2SO_4$ Concentration Grams. | Apparent F Micrograms. | Added F Micrograms. | Total F Micrograms. |
|---|---|---|---|---|---|
| 1 | 0·30 | $0·147 \times 10^{-3}$ | — | 2 | 2·8 |
| 2 | 0·30 | $0·147 \times 10^{-3}$ | 0·70 | 3 | 3·6 |
| 3 | 0·30 | $0·147 \times 10^{-3}$ | 0·70 | 4 | 4·6 |
| 4 | 0·30 | $0·147 \times 10^{-3}$ | 0·70 | 5 | 5·5 |
| 5 | 0·30 | $0·147 \times 10^{-3}$ | 0·70 | 6 | 6·6 |
| 6 | 0·30 | $0·147 \times 10^{-3}$ | 0·70 | 7 | 7·4 |
| 7 | 0·30 | $0·147 \times 10^{-3}$ | 0·70 | 8 | 8·5 |
| 8 | 0·30 | $0·147 \times 10^{-3}$ | 0·70 | 9 | 9·4 |
| 9 | 0·30 | $0·147 \times 10^{-3}$ | 0·70 | 10 | 10·4 |

The average acidity of five lots of blank sulphuric acid distillates is of the order 0·3 ml. 0·01 N NaOH per 40 ml. volumes (Table VI). Following the procedure advocated by Willard and Winter (1933), Armstrong (1936) etc., i.e. neutralization of the distillate by means of sodium hydroxide, a sodium sulphate concentration of the order $0·213 \times 10^{-3}$ grams per 40 ml. would be obtained.

The effect of sulphuric acid* and sodium sulphate, added to produce concentrations of the above-mentioned order, was investigated in the presence of 1 to 10 micrograms added fluorine (Table VII).

The detrimental effect of the sulphate ion has already been noted by de Boer and Basart (1925), in their original exposition of the basic reaction.

Hoskins and Ferris (1936) state that a sulphate concentration of $1 \times 10^{-6}$M is necessary to produce an appreciable effect on the titration of the fluorine ion by means of thorium nitrate.

Eberz, Lamb and Lachele (1938) investigated the effect produced by the sulphate ion in alcoholic solutions and conclude that the error caused by sulphates increase with a corresponding increase in fluorine content.

Reynolds and Hill (1939) confirmed the findings of Eberz *et al* (1938) to the effect that the interference due to the sulphate ion is dependent upon the amount of fluorine present, if titration is executed in alcoholic solution. According to these workers, the interference of the sulphate ion disappears almost entirely in aqueous solutions.

Fellenberg (1937), apparently encountered no interference as the result of adopting sulphuric acid for the separation of fluorine from biological material. Fellenberg definitely states that the subsequent titrimetric determination (modification of the Armstrong micro procedure) should be executed in the entire absence of the sulphate ion. The fact that sulphuric acid apparently does not find its way into Fellenberg's distillate may be accounted for by the low volatilization temperature (125° C.) advocated by this worker.

TABLE VII.

*The Effect of Added* $H_2SO_4$ *and* $Na_2SO_4$ *on the Recovery of Fluorine.*

| Tube No. | $Na_2SO_4$ Concentration Grams. | Added F Micro-grams. | Found F Micro-grams. | $H_2SO_4$ Concentration Grams. | Added F Micro-grams. | Found F Micro-grams. |
|---|---|---|---|---|---|---|
| A | $0·071 \times 10^{-3}$... | 0 | 0·6 | $0·049 \times 10^{-3}$... | 0 | 0·4 |
| B | $0·142 \times 10^{-3}$... | 0 | 1·1 | $0·098 \times 10^{-3}$... | 0 | 0·7 |
| C | $0·213 \times 10^{-3}$... | 0 | 1·2 | $0·147 \times 10^{-3}$... | 0 | 1·0 |
| D | $0·284 \times 10^{-3}$... | 0 | 1·5 | $0·196 \times 10^{-3}$... | 0 | 1·2 |
| E | $0·355 \times 10^{-3}$... | 0 | 1·8 | $0·245 \times 10^{-3}$... | 0 | 1·4 |
| A | $0·071 \times 10^{-3}$... | 1 | 1·7 | $0·049 \times 10^{-3}$... | 1 | 1·5 |
| B | $0·142 \times 10^{-3}$... | 1 | 2·0 | $0·098 \times 10^{-3}$... | 1 | 1·8 |
| C | $0·213 \times 10^{-3}$... | 1 | 2·1 | $0·147 \times 10^{-3}$... | 1 | 1·9 |
| D | $0·284 \times 10^{-3}$... | 1 | 2·5 | $0·196 \times 10^{-3}$... | 1 | 2·3 |
| E | $0·355 \times 10^{-3}$... | 1 | 3·0 | $0·245 \times 10^{-3}$... | 1 | 2·5 |
| A | $0·071 \times 10^{-3}$... | 5 | 5·3 | $0·049 \times 10^{-3}$... | 5 | 5·3 |
| B | $0·142 \times 10^{-3}$... | 5 | 5·7 | $0·098 \times 10^{-3}$... | 5 | 5·6 |
| C | $0·213 \times 10^{-3}$... | 5 | 6·1 | $0·147 \times 10^{-3}$... | 5 | 6·0 |
| D | $0·284 \times 10^{-3}$... | 5 | 6·6 | $0·196 \times 10^{-3}$... | 5 | 6·3 |
| E | $0·355 \times 10^{-3}$... | 5 | 7·1 | $0·245 \times 10^{-3}$... | 5 | 6·5 |
| A | $0·071 \times 10^{-3}$... | 10 | 10·4 | $0·049 \times 10^{-3}$... | 10 | 10·5 |
| B | $0·142 \times 10^{-3}$... | 10 | 11·1 | $0·098 \times 10^{-3}$... | 10 | 10·8 |
| C | $0·213 \times 10^{-3}$... | 10 | 11·4 | $0·147 \times 10^{-3}$... | 10 | 11·2 |
| D | $0·284 \times 10^{-3}$... | 10 | 11·9 | $0·196 \times 10^{-3}$... | 10 | 11·4 |
| E | $0·355 \times 10^{-3}$... | 10 | 12·2 | $0·245 \times 10^{-3}$... | 10 | 11·8 |

From a comparison of Tables VII and V it is observed that added sulphuric acid gives rise to a larger blank fluorine value, than a like sulphuric acid concentration encountered in actual blank distillates.

It was already pointed out that the error introduced by the use of sulphuric acid as volatilizing agent, is reduced by added fluorine. The same phenomenon is encountered in instances where sodium sulphate and sulphuric acid are added to a standard fluorine series (Table VII). It is observed that the blank error resulting from both sodium sulphate and sulphuric acid, is reflected quantitatively in the recovery of 1 microgram of added fluorine, whereas a marked decrease in the error is encountered, passing from 1 to 5 micrograms of added fluorine. Strangely enough, in the range 5 to 10 micrograms of added fluorine a slight increase in the actual blank error is encountered in the case of both sulphuric acid and sodium sulphate, for the same sulphate ion concentrations. The plus errors as reflected by the recovery of added fluorine are greater in the case of sodium sulphate than of sulphuric acid. This suggests that the neutralization of the free acid in the distillate with sodium hydroxide, to effect evaporation, as advocated in the majority of methods for the deternation of fluorine, introduces an additional plus error of variable size. The detrimental effect of sulphate traces is surprising if it is taken into consideration that thorium sulphate is a comparatively soluble salt. The conductivity measurements of Barre (1910) show that even a 0·001 M solution is by no means completely dissociated. The weakness of the salt will naturally be greatly increased in alcoholic solutions, which may feasibly account for the difference encountered by Reynolds and Hill (1939) between alcoholic and aqueous medium, as far as the interference due to the sulphate ion is concerned. Reynolds and Hill (1939) expressed the opinion that the sulphate ion interferes as a result of giving rise to insoluble salts of the type $ThF_2SO_4$. This can, however, hardly account for the significant increase in apparent fluorine content, concomitant with an increase in sulphate ion concentration, in the absence of fluorine (Table VII). The slight dissociation of thorium sulphate may readily account for this phenomenon.

Perchloric acid on account of the solubility of the perchlorates, is a most suitable acid for the volatilization of fluorine. The perchloric acid distillation of phosphatic materials, invariably leads to the presence of orthophosphate in the distillate (Churchill *et al*, 1937), causing plus errors in the determination.

In this laboratory it was observed that phosphate subjected to distillation in the pyro form has a tendency to find its way into the distillate, whereas the distillation of small quantities of orthophosphate is devoid of this distressing feature. Virtually, this is the principle underlying the postulate of Churchill (1935) to the effect that a double perchloric acid distillation yields a distillate free from any orthophosphate.

The effect of partially volatilized perchloric acid in the distillate on the subsequent determination was established by following similar lines to those adopted in the case of sulphuric acid. In this experiment 200 ml. volumes of distillate were collected at 130° C. from five lots of perchloric acid (5 ml. 60 per cent. perchloric acid + 10 ml. water. The same precautions were taken as in the distillation of sulphuric acid. Again the near constancy of acidity and apparent fluorine content of blank distillates, collected under uniform conditions is striking (Table VIII).

The total apparent fluorine value of the blank distillates is of the same order as that encountered by McClure (1939) in his investigation of the Armstrong procedure.

Eberz, Lachele and Lamb (1938) advocates the purification of $HClO_4$ by continual distillation until the Blank is zero. The author was unable to confirm the findings of these workers.

Prolonged treatment of perchloric acid at 160° prior to distillation did not alter the magnitude of the apparent fluorine value of the blank.

## TABLE VIII.

*The Acidity and apparent Fluorine Content of Blank Perchloric Acid Distillates.*

| Distillate No. | 0·01 N. NaOH ml. | $HClO_4$ Concentration Grams. | 0·05 N. HCl ml. | Apparent F Value Micrograms. |
|---|---|---|---|---|
| 1 | 0·49 | $0{\cdot}492 \times 10^{-3}$ | 1·90 | 0·30 |
| 2 | 0·54 | $0{\cdot}543 \times 10^{-3}$ | 1·89 | 0·50 |
| 3 | 0·50 | $0{\cdot}503 \times 10^{-3}$ | 1·90 | 0·50 |
| 4 | 0·56 | $0{\cdot}563 \times 10^{-3}$ | 1·89 | 0·40 |
| 5 | 0·56 | $0{\cdot}563 \times 10^{-3}$ | 1·89 | 0·30 |

All values in Table VIII for 40 ml. aliquots of distillate.

The intensity of bleach displayed by the blank perchloric acid distillates towards the alizarin compound is reduced to zero by the addition of fluorine (Table IX). The minus error obtained in the case of 20 micrograms of added fluorine, is in line with the findings of Reynolds and Hill (1939) who encountered significant apparent fluorine values for blank perchloric acid distillates, but on addition of this blank to a sodium fluoride solution of known concentration, a lowered titer was encountered.

## TABLE IX.

*The Effect of Added Fluorine on the Blank Bleach.*

| Sample No. | 0·01 N. NaOH ml. | $HClO_4$ Concentration Grams. | Apparent F Micrograms. | Added F Micrograms. | Found F Micrograms |
|---|---|---|---|---|---|
| 1 | 0·52 | $0{\cdot}523 \times 10^{-3}$ | 0·50 | 2 | 2·4 |
| 2 | 0·52 | $0{\cdot}523 \times 10^{-3}$ | 0·50 | 3 | 3·3 |
| 3 | 0·52 | $0{\cdot}523 \times 10^{-3}$ | 0·50 | 4 | 4·3 |
| 4 | 0·52 | $0{\cdot}523 \times 10^{-3}$ | 0·50 | 5 | 5·3 |
| 5 | 0·52 | $0{\cdot}523 \times 10^{-3}$ | 0·50 | 6 | 6·2 |
| 6 | 0·52 | $0{\cdot}523 \times 10^{-3}$ | 0·40 | 7 | 7·2 |
| 7 | 0·52 | $0{\cdot}523 \times 10^{-3}$ | 0·50 | 8 | 8·2 |
| 8 | 0·52 | $0{\cdot}523 \times 10^{-3}$ | 0·50 | 9 | 9·0 |
| 9 | 0·52 | $0{\cdot}523 \times 10^{-3}$ | 0·50 | 10 | 10·1 |
| 10 | 0·52 | $0{\cdot}523 \times 10^{-3}$ | 0·50 | 20 | 19·8 |

This experiment was carried out with 40 ml. aliquots obtained from a mixture of distillates No. 1-5 (Table VIII).

The next step was to establish the effect of added perchloric acid and sodium perchlorate, on the recovery of fluorine. Perchloric acid and sodium perchlorate were added to a standard fluorine series, in a concentration of the same order, and up to tenfold the concentration as encountered in distillates from this acid. The recovery of the fluorine from the standard series (0 to 10 microg.) was determined.

## TABLE X.

### *The Effect of $HClO_4$ and $NaClO_4$ on the Recovery of Added Fluorine.*

| Tube No. | $NaClO_4$ Concentration Grams. | F Added Micrograms. | F Found Micrograms. | $HClO_4$ Concentration Grams. | F Added Micrograms. | F Found Micrograms. |
|---|---|---|---|---|---|---|
| A | 0·613 × $10^{-3}$... | 0 | 0 | 0·503 × $10^{-3}$... | 0 | 0 |
| B | 1·226 × $10^{-3}$... | 0 | 0 | 1·006 × $10^{-3}$... | 0 | 0 |
| C | 1·839 × $10^{-3}$... | 0 | 0 | 1·509 × $10^{-3}$... | 0 | 0 |
| D | 3·065 × $10^{-3}$... | 0 | 0·2 | 2·515 × $10^{-3}$... | 0 | 0 |
| E | 4·291 × $10^{-3}$... | 0 | 0·2 | 3·521 × $10^{-3}$... | 0 | 0 |
| F | 6·130 × $10^{-3}$... | 0 | 0·5 | 5·030 × $10^{-3}$... | 0 | 0 |
| A | 0·613 × $10^{-3}$... | 1·0 | 1·0 | 0·503 × $10^{-3}$... | 1·0 | 1·0 |
| B | 1·226 × $10^{-3}$... | 1·0 | 1·0 | 1·006 × $10^{-3}$... | 1·0 | 1·0 |
| C | 1·839 × $10^{-3}$... | 1·0 | 1·0 | 1·509 × $10^{-3}$... | 1·0 | 1·0 |
| D | 3·065 × $10^{-3}$... | 1·0 | 1·1 | 2·515 × $10^{-3}$... | 1·0 | 1·0 |
| E | 4·290 × $10^{-3}$... | 1·0 | 1·3 | 3·521 × $10^{-3}$... | 1·0 | 1·0 |
| F | 6·130 × $10^{-3}$... | 1·0 | 1·6 | 5·030 × $10^{-3}$... | 1·0 | 1·0 |
| A | 0·613 × $10^{-3}$... | 3·0 | 3·0 | 0·503 × $10^{-3}$... | 3·0 | 3·0 |
| B | 1·226 × $10^{-3}$... | 3·0 | 3·0 | 1·006 × $10^{-3}$... | 3·0 | 3·0 |
| C | 1·839 × $10^{-3}$... | 3·0 | 3·0 | 1·509 × $10^{-3}$... | 3·0 | 3·0 |
| D | 3·065 × $10^{-3}$... | 3·0 | 3·0 | 2·515 × $10^{-3}$... | 3·0 | 3·0 |
| E | 4·291 × $10^{-3}$... | 3·0 | 3·4 | 3·521 × $10^{-3}$... | 3·0 | 3·0 |
| F | 6·130 × $10^{-3}$... | 3·0 | 3·5 | 5·030 × $10^{-3}$... | 3·0 | 3·0 |
| A | 0·613 × $10^{-3}$... | 5·0 | 5·0 | 0·503 × $10^{-3}$... | 5·0 | 5·0 |
| B | 1·336 × $10^{-3}$... | 5·0 | 5·0 | 1·006 × $10^{-3}$... | 5·0 | 5·0 |
| C | 1·839 × $10^{-3}$... | 5·0 | 5·0 | 1·509 × $10^{-3}$... | 5·0 | 5·0 |
| D | 3·065 × $10^{-3}$... | 5·0 | 5·2 | 2·515 × $10^{-3}$... | 5·0 | 5·0 |
| E | 4·291 × $10^{-3}$... | 5·0 | 5·4 | 3·521 × $10^{-3}$... | 5·0 | 5·0 |
| F | 6·130 × $10^{-3}$... | 5·0 | 5·7 | 5·030 × $10^{-3}$... | 5·0 | 5·0 |
| A | 0·613 × $10^{-3}$... | 7·0 | 7·0 | 0·503 × $10^{-3}$... | 7·0 | 7·0 |
| B | 1·226 × $10^{-3}$... | 7·0 | 7·0 | 1·006 × $10^{-3}$... | 7·0 | 7·0 |
| C | 1·839 × $10^{-3}$... | 7·0 | 7·0 | 1·509 × $10^{-3}$... | 7·0 | 7·0 |
| D | 3·065 × $10^{-3}$... | 7·0 | 7·3 | 2·515 × $10^{-3}$... | 7·0 | 7·0 |
| E | 4·291 × $10^{-3}$... | 7·0 | 7·5 | 3·521 × $10^{-3}$... | 7·0 | 7·0 |
| F | 6·130 × $10^{-3}$... | 7·0 | 7·6 | 5·030 × $10^{-3}$... | 7·0 | 7·0 |
| A | 0·613 × $10^{-3}$... | 10·0 | 10·0 | 0·503 × $10^{-3}$... | 10·0 | 10·0 |
| B | 1·226 × $10^{-3}$... | 10·0 | 10·0 | 1·006 × $10^{-3}$... | 10·0 | 10·0 |
| C | 1·839 × $10^{-3}$... | 10·0 | 10·2 | 1·509 × $10^{-3}$... | 10·0 | 10·0 |
| D | 3·065 × $10^{-3}$... | 10·0 | 10·2 | 2·515 × $10^{-3}$... | 10·0 | 10·0 |
| E | 4·291 × $10^{-3}$... | 10·0 | 10·6 | 3·521 × $10^{-3}$... | 10·0 | 10·0 |
| F | 6·130 × $10^{-3}$... | 10·0 | 10·8 | 5·030 × $10^{-3}$... | 10·0 | 10·0 |

Perchloric acid up to a concentration of $5 \cdot 03 \times 10^{-3}$ grams per 43 ml. has no effect on the recovery of added fluorine in a range of 0 to 10 micrograms (Table X).

All tubes are controlled at a total acidity equivalent to 2 ml. 0·05 N acid by means of HCl. Thus from Table X it appears that for the purpose of controlling the pH, perchloric acid may partially and totally be substituted for hydrochloric acid. Dahle *et al* (1938) found that a total substitution of perchloric for hydrochloric acid has no bearing on the results obtained.

It is evident thus, that the blank values obtained for perchloric acid distillates (Table VIII) cannot be ascribed to the presence of free perchloric acid.

On the other hand it is observed that as a result of neutralization and the consequent introduction of the sodium ion, errors are introduced when the concentration of the sodium perchlorate reaches approximately $3 \times 10^{-3}$ grams per 43 ml. (Table X).

Reynolds and Hill (1939) observed interferences as a result of the presence of the sodium ion, in semi-micro titrimetric work. They found that by adding sodium salts to the solution towards the end of the titration, little or no effect is produced on the titer, suggesting that the interference arises from reactions taking place when the fluorine ion is still available. The formation of insoluble salts of the type $Na_2 ThF_6$ may feasibly explain interferences due to the presence of the sodium ion. The statement of these authors to the effect that the potassium and ammonium ions cause interferences of a lesser degree, thus becomes apparent.

Dahle *et al* (1938) encountered interferences as a result of neutralization. According to these authors " this salt error may be due either to some change in the reaction between thorium, fluorine, and the indicator, or, more probably, to the effect of the salts on the pH, sodium alizarin sulphonate being an indicator rather sensitive to salt effects ".

## THE SIGNIFICANCE OF CHLORIDES.

Chlorides are invariably present in all fluorine bearing material, sometimes in excessive amounts. The chlorides will subsequently be quantitatively present in the distillate as hydrochloric acid (Fellenberg, 1937) and its presence must duly be considered.

In this study a pH of 2·74 (Dahle *et al*, 1938) was adopted, at which all standards and unknowns are to be compared. The acid equivalence to this pH is 2 ml. 0·05 N per 40 ml. volumes.

It is at once evident, that if the charge in the distillation flask contains more than 17 mg. chlorine, the total acidity of the distillate will be in excess of 10 ml. 0·05 N acid. If the presence of chlorides, in excess of the above-mentioned magnitude, is suspected, its removal must be effected.

In the literature several methods are encountered, to safeguard the distillation from the presence of hydrochloric acid. Dahle (1937) advocates the removal of chlorides by heating the charge with sulphuric acid and the potassium permanganate equivalent of the original chlorine concentration, fitting a reflux condenser to the distillation flask. In the authors' hands, the use of both potassium permanganate and dichromate, resulted in low recoveries of added fluorine presumably due to the formation of manganese and chromium-fluorine complexes. In the presence of ammonium salts this procedure is dangerous. Armstrong (1936) removes chlorides from the first distillate with a solution of silver perchlorate. The evaporated filtrate is redistilled and the second distillate is subjected to a treatment with activated charcoal. This procedure is impracticable. Eberz, Lamb and Lachelle (1938) advocates the incorporation of silver perchlorate in the distilling flask, carefully avoiding any excess of silver salt.

The author found the use of solid silver sulphate, as advocated by McClure (1939) entirely satisfactory. If a single distillation is sufficient, solid silver sulphate (a slight excess is of no significance) is added to the charge in the flask. Before steam is passed through, bumping is avoided by passing a slow stream of nitrogen through the unit. At 130° C. the nitrogen current is disconnected and steam passed through. If a double distillation proves necessary the solid silver sulphate is added to the concentrated distillate and the latter redistilled. Precipitation and subsequent filtration of the silver chloride from the first distillate did not prove satisfactory due to the finely divided nature of the precipitate, which defies filtration.

The recovery of fluorine in duplicate and the recovery of added fluorine, in conjunction with the removal of chlorides will be discussed under the determination of fluorine in whole blood.

The effect of chloride as sodium chloride on the recovery of added fluorine, was investigated to determine the permissible range of a neutralization of the distillate by means of sodium hydroxide (Table XI). It is observed that the presence of the sodium ion is manifested by interference when the concentration of sodium chloride reaches $4 \cdot 095 \times 10^{-3}$ grams per 43 ml. in the absence of fluorine, and with a fluorine content of 10 micrograms an error of 6 per cent. is caused.

The advantage of executing the determination, avoiding neutralization, becomes apparent. In cases where neutralization and evaporation of the entire distillate is imperative, the sodium chloride concentration prior to actual determination should not be in excess of $2 \cdot 925 \times 10\text{-}3$ grams per 43 ml., i.e. the total neutralizing value in terms of 0·01 NaOH should not exceed 5 ml.

The sodium chloride concentration causing interferences, according to McClure (1939) and Dahle (1938) is significantly higher than the concentrations causing plus errors in Table XI.

Fellenberg (1937) states that sodium chloride exerts no interference in the titrimetric procedure adopted by him, being a modification of the Armstrong (1936) micro procedure.

## THE QUESTION OF THE EVAPORATION OF THE ALKALINE DISTILLATE.

If only minute quantities of fluorine find their way into the final distillate, the logic approach to the problem of analysis lies in the evaporation of the alkaline distillate, the sensitivity of the determination being thus enhanced. It has already been pointed out that as a result of neutralization the total sodium chloride concentration should not be in excess of $2 \cdot 925 \times 10^{-3}$ grams per 43 ml.

The method of evaporation of the distillate appears to be of cardinal importance. The author has repeatedly encountered low recoveries of fluorine traces when the alkaline distillates were evaporated in glass.

### TABLE XI.

*The effect of Sodium Chloride on the Recovery of Added Fluorine. All values in Table XI per 43 ml. volumes.*

| Tube No. | NaCl Concentration Grams. | 0·05 N. HCl ml. | Added Fluorine Micrograms. | Found Fluorine Micrograms. |
|---|---|---|---|---|
| A | $0{\cdot}585 \times 10^{-3}$ | 2 | 0 | 0 |
| B | $1{\cdot}755 \times 10^{-3}$ | 2 | 0 | 0 |
| C | $2{\cdot}925 \times 10^{-3}$ | 2 | 0 | 0 |
| D | $4{\cdot}095 \times 10^{-3}$ | 2 | 0 | 0·1 |
| E | $5{\cdot}850 \times 10^{-3}$ | 2 | 0 | 0·2 |
| A | $0{\cdot}585 \times 10^{-3}$ | 2 | 2·0 | 2·0 |
| B | $1{\cdot}755 \times 10^{-3}$ | 2 | 2·0 | 2·0 |
| C | $2{\cdot}925 \times 10^{-3}$ | 2 | 2·0 | 2·1 |
| D | $4{\cdot}095 \times 10^{-3}$ | 2 | 2·0 | 2·2 |
| E | $5{\cdot}850 \times 10^{-3}$ | 2 | 2·0 | 2·4 |
| A | $0{\cdot}585 \times 10^{-3}$ | 2 | 5·0 | 5·0 |
| B | $1{\cdot}755 \times 10^{-3}$ | 2 | 5·0 | 5·0 |
| C | $2{\cdot}925 \times 10^{-3}$ | 2 | 5·0 | 5·2 |
| D | $4{\cdot}095 \times 10^{-3}$ | 2 | 5·0 | 5·5 |
| E | $5{\cdot}850 \times 10^{-3}$ | 2 | 5·0 | 5·5 |
| A | $0{\cdot}585 \times 10^{-3}$ | 2 | 10·0 | 10·0 |
| B | $1{\cdot}755 \times 10^{-3}$ | 2 | 10·0 | 10·0 |
| C | $2{\cdot}925 \times 10^{-3}$ | 2 | 10·0 | 10·4 |
| D | $4{\cdot}095 \times 10^{-3}$ | 2 | 10·0 | 10·6 |
| E | $5{\cdot}850 \times 10^{-3}$ | 2 | 10·0 | 10·7 |

The work of McClure (1939) has cleared up this distressing feature. He found low recoveries of added fluorine when evaporation was accomplished in glass, but quantitative recoveries by evaporation in platinum. The effect produced by evaporation in glass as compared to the use of platinum is illustrated in the determination of the fluorine content of normal bovine blood (Table XII).

## RARE CONTAMINANTS.

Numerous substances, resulting in serious interferences in the determination of fluorine by methods based on the reaction of de Boer and Basart (1926), have been reported by Willard and Winter (1933), Kolthoff and Stansby (1934), Sanchis (1933), Fellenberg (1937), Reynolds and Hill (1939), etc. These interfering substances of which soluble aluminium salts, boron, gelatinous silica, nitrite, nitrate, pyritic sulphur, sulphite, etc., are few. These substances are however not ordinarily encountered in biological material.

Lockwood (1937) pointed out the serious errors that may result on account of the presence of manganese traces in ashed samples. A portion of the hydrochloric acid formed, under these conditions, will be oxidized to free chlorine causing serious errors in the determination. Lockwood (1937) advocates the use of sodium nitrite to destroy the free chlorine, a practice which cannot be employed in the method advocated in this study. According to Lockwood the method of Barr and Thorogood (1934) cannot be applied to the determination of fluorine in domestic waters subjected to chlorination. The author found distillation by means of sulphuric acid-indigo-sulphonic acid (Fellenberg, 1937) satisfactory for nullifying the ill-effects of free chlorine.

## THE DETERMINATION OF THE FLUORINE CONTENT OF NORMAL BOVINE BLOOD.

McClure (1939) in his study on the applicability of the Armstrong micro procedure, reports that this method cannot be successfully applied to the determination of the fluorine content of foodstuffs containing less than 1 p.p.m. fluorine, skim milk powder being a case in point.

The determination of the fluorine content of normal bovine blood was attempted in this study on account of its low fluorine content and the difficulty encountered in ashing large quantities of blood.

### PROCEDURE.

350 c.c. of blood was collected from a bovine on a low fluorine ration. The use of sodium oxalate as anti-coagulant proved unsatisfactory on account of the tendency towards the formation of magnetic iron oxide on ashing. If the ashing of blood is accompanied by the formation of this oxide, difficulty is encountered in the removal of the ash which firmly adheres to the sides of the combustion vessel. A mixture of ammonium oxalate and ammonium citrate was successfully adopted as anticoagulant.

The blood (20 c.c.) is transferred to a platinum basin of 100 ml. capacity and 5 ml. saturated $Ca(OH)_2$ solution added. The basin is placed on the steam bath for about half an hour, transferred to an air-bath (+150° C.) for approximately 15 minutes and placed in the muffle. The temperature is increased gradually to 450° C. at which temperature ashing is completed within one hour, without any trouble being encountered with frothing and spluttering. A second 20 ml. volume of blood is introduced and the process repeated, ashing a total volume of 60 ml. whole blood.

The ash is transferred to the distillation flask with a minimum of doubly distilled water. The volume of water and ash in the flask should not exceed 15 ml. (evaporate if necessary). Add 0·05 grams silica and a couple of glass beads. The apparatus is assembled and 8 ml. $H_2SO_4$ S.G. 1·84 (previously treated as described) is slowly run down the capillary. The acid will accumulate in the bottom of the flask. A sudden mixing of the acid and the ash solution should be avoided. Gradual and satisfactory mixing can be achieved by forcing a very slow nitrogen stream down the capillary.

The temperature is gradually brought to 140° C. and steam passed through, collecting 200 ml. distillate. The distillate is titrated with 0·5 N NaOH against a minimum of phenolphthalein as indicator, to ascertain the total acidity as HCl (Fellenberg). Thus the total chloride concentration of the blood sample is established. The distillate, after titration, is evaporated (in glass) to a small volume, care being taken to retain the pink colour of the phenolphthalein during evaporation. The evaporated distillate is transferred to the distilling flask (total volume ±15 ml.) and the chloride equivalence of solid $Ag_2SO_4$ added. The apparatus is assembled and 7·5 ml. perchloric acid introduced through the capillary. The temperature is gradually raised to 130° C., bumping being avoided by passing a slow nitrogen stream through the unit. At 130° C. the nitrogen current is switched off and steam passed in, maintaining the temperature at 130° C., and collecting 200 ml. distillate. The fluorine determination is executed on 40 ml. aliquot samples of the distillate as described. The results are tabulated in Table XII.

### Table XII.

*The Fluorine Content of Normal Blood (Bovine), and the Recovery of Added F.*

| Blood Vol. c.c. | 1st Distillate. | | F Added Micrograms. | 2nd Distillate. | | Blood F Micrograms. Per cent. |
|---|---|---|---|---|---|---|
| | 0·50 N. NaOH ml. | Blood Cl. mg. Per cent. | | 0·01 N. NaOH ml. | 0·05 N. HCl ml. | |
| A 60 | 9·05 | 267 | 0 | 2·05 | 1·59 | 44·8 |
| B 60 | 9·28 | 274 | 0 | 1·30 | 1·74 | 46·0 |
| C 60 | 9·42 | 279 | 0 | 1·82 | 1·63 | 47·2 |
| D 60 | 9·36 | 277 | 20 | 2·12 | 1·57 | 62·5 |
| E 60 | 9·12 | 269 | 50 | 1·55 | 1·69 | 91·5 |

1st Distillate = Titration Value of Total Distillate.
2nd Distillate = Values per 40 ml. aliquots of distillate.

It is observed from Table XII that in the second distillate, the neutralizing value of 40 ml. aliquots, in terms of 0·01 N NaOH in all cases exceeds 1·0 ml. Thus the determination could not have been executed on the total distillates. The $Ag_2SO_4$ was added in a theoretical equivalence to the chloride concentration as established by titration (Table XII). The high acidity of the second distillate may thus be ascribed to a slight preponderance of the chloride over the silver ion.

Blood fluorine determinations may be duplicated with a gross error of the order of 5 per cent. (Table XII). The recovery of 20 to 50 micrograms of fluorine added to whole blood, amounts to approximately 83 and 92 per cent. respectively. (Taking the average values of A, B and C.) The low recovery of added sodium fluoride may be due to the preponderance of soluble iron salts in the charge, or due to loss on ignition. The first contingency was investigated by treating blood ash with concentrated sulphuric acid and silica in a platinum dish at 200° C. to expel the last traces of fluorine. The recovery of fluorine added to this fluorine-free salt residue, again falls within the 5 per cent. error limit. Apparently the concentration of iron salts encountered in blood ash does not exert an inhibitory effect on the volatilization of fluorine, loss on ignition has not been investigated. This phase of the determination of fluorine has been carefully studied by Hoskins and Ferris (1936). These workers added sodium fluoride to ripe apple pulp and combusted the samples at different temperatures. Even at a temperature of 720° C. a recovery of 97 per cent. was obtained. In the ashing of the blood samples a temperature of 500° C. was never exceeded. One has to bear in mind, however, the possibility of an acid resisting iron-fluorine complex being formed during combustion. In this connection, the effect of fusing the ash with $Na_2CO_3$, prior to distillation, on the recovery of added fluorine, is still being investigated.

TABLE XIII.

*Glass vs. Platinum for the Evaporation of the Alkaline Distillate.*

| Dist. Vol. ml. | Evaporation. | 0·01 N. NaOH ml. | NaCl Concentration. Grams. | 0·05 N. HCl ml. | Fluorine p. 40 c.c. Micrograms. |
|---|---|---|---|---|---|
| A 40....... | — | 1·69 | $0{\cdot}988 \times 10^{-3}$... | 1·66 | 5·3 |
| B 40....... | — | 5·50 | $3{\cdot}210 \times 10^{-3}$... | 0·90 | 5·7 |
| C 120....... | Glass...... | 5·50 | $3{\cdot}210 \times 10^{-3}$... | 0·90 | 4·5 |
| D 120....... | Platinum.. | 5·50 | $3{\cdot}210 \times 10^{-3}$... | 0·90 | 5·8 |

A mixture of the second distillates [A, B and C (Table XII)] was used to establish the relative effect on the recovery of fluorine, after evaporation, using glass (Jena) and platinum.

Sample A is a natural 40 ml. aliquot as obtained from a mixture of distillates A, B and C (Table XII) whereas in sample B the same concentration of sodium hydroxide, as necessitates the neutralization of samples C and D, has been incorporated. The total volumes in all cases were controlled at 43 ml.

The high values obtained in the case of samples B and D may be attributed to the sodium chloride concentration.

Evaporation in Jena glass gave rise to a minus error of approximately 15 per cent.

## SUMMARY.

A method of the micro determination of fluorine based on the bleaching effect of the fluorine ion towards the thorium lake of the anthraquinone dyes sodium alizarin sulphonate and alizarin Bordeaux is described. This procedure is not concerned with the determination of more than 100 micrograms of fluorine per 200 ml. distillate.

1. Neutralization of the acid distillate is avoided, the total acidity in both standards and samples being controlled equivalent to 2 ml. 0·05 N acid (hydrochloric or perchloric acid) per 43 ml. volumes. The pH of the medium is 2·74.

2. The need for controlling the indicator concentration at a constant throughout the series is emphasized by the variations observed in the titer of the thorium solution, at varying indicator concentrations.

3 A sodium fluoride of satisfactory purity may be prepared by the method of Reynolds and Hill (1939).

4. The use of a standard sodium fluoride solution for the determination of 20 micrograms of fluorine as silico fluoride may be accomplished at a pH 2·74 without the use of a buffer.

5. The use of sulphuric acid as final volatilizing agent cannot be recommended. Even under the most favourable conditions plus errors are caused due to the presence of the sulphate ion.

6. Blank distillates collected from perchloric acid exhibit a bleaching effect towards the alizarin compound. This bleaching effect is not due to fluorine, as added fluorine results in a decrease of this plus error. Neither is this apparent fluorine value due to partially volatilized perchloric acid. The magnitude of the apparent fluorine value is not influenced by treating the perchloric acid at 160° C. prior to distillation.

7. The introduction of the sodium ion is manifested by plus errors when the concentration of sodium chloride reaches $4 \cdot 095 \times 10^{-3}$ grams per 43 ml. in the absence of fluorine and $2 \cdot 925 \times 10^{-3}$ grams per 43 ml. in the presence of 10 micrograms of fluorine. The corresponding concentrations for sodium perchlorate are $3 \cdot 063 \times 10^{-3}$ and $1 \cdot 839 \times 10^{-3}$ grams per 43 ml. respectively.

8. The evaporation of the alkaline distillate in glass leads to a minus error of variable size. Quantitative recoveries are observed when evaporation is effected in platinum.

9. A method for the complete ashing of blood at low temperatures is described and the subsequent fluorine determination on the ash may be duplicated with a maximum error of 5 per cent. A low recovery of added fluorine to whole blood was encountered, presumably due to the formation of acid resisting iron-fluorine complexes on ashing. Blood iron converted to ferric sulphate has no inhibitory effect on the volatilization of added fluorine.

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# Section V.

# Nutrition.

| | | |
|---|---|---|
| MARAIS, J. S. C. AND SMUTS, D. B. | Further studies on the amino acid deficiencies of plant proteins ... ... | 387 |
| SMUTS, D. B. AND MARAIS, J. S. C. | The dry matter consumption of sheep on natural grazing in the Transvaal | 403 |
| SMUTS, D. B. AND MARAIS, J. S. C. | The utilization by sheep of the proteins contained in the natural grazing during different seasons of the year | 415 |
| MYBURGH, S. J. ... ... | The carotene content of some South African feeds ... ... ... ... ... ... ... ... ... ... | 421 |

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# Further Studies on the Amino Acid Deficiencies of Plant Proteins.

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In a previous paper (1938), it was pointed out that the nature of the amino acid deficiencies in natural protein feeds is an essential factor in the qualitative selection of protein mixtures: that there exists no direct method of determining the nature of these amino acids and that the chemical analyses may reveal to some extent the value of a protein, but are of no actual biological significance unless correlated with the biological requirements of the animal. Mitchell (1938) fully endorsed this statement on the value of chemical analyses. He states " that even with all the chemical and biochemical information before us, the quantitative evaluation of protein diversities in nutrition would not be solved because the information neglects the animal ".

It appears that the best method at present to study the nature of the amino acid deficiencies in protein feeds is to supplement different protein feeds with the suspected deficient amino acids. These supplementations are then compared with the unsupplemented protein feeds on young rats by means of the paired feeding method under identical conditions. Since the only difference in these comparisons is the inclusion of a small amount of a specific amino acid, it is reasonable to attribute any significant gain in weight in favour of the supplemented ration, to the inclusion of the amino acid. However, gain in weight alone is a non-specific criterion of nutritive value. Unless therefore in studies of this nature, the gains in weight can be defined or correlated with increased nitrogen storage, the results are inconclusive and have a dual interpretation. Conclusive proof, as to whether the greater gains induced by the amino acid inclusion are due to a better utilization of the nitrogen contained in the protein under experimentation can be obtained either by a complete nitrogen analysis of rats in each pair or by a determination of the biological value of the supplemented and unsupplemented ration. The latter method was adopted in preference to the first, since it fitted into our general programme of protein investigation. Briefly then the method adopted in this Laboratory for the determination of amino acid deficiencies in protein feeds is as follows: The nature of the amino acid deficiency is first established by means of the paired feeding method. If by statistical analysis, it is found that the supplemented ration produces greater gains than the unsupplemented ration, then the biological value of the same rations containing the same percentage of nitrogen is determined. By this means the greater gain in weight is supported by nitrogen utilization figures and definite conclusions can be arrived at. No difference in growth response in the paired feeding test signifies no supplementation and consequently nitrogen balance studies are conducted only in selected cases.

Most of the plant proteins except sesamemeal and cottonseedmeal have already been supplemented by some or other of the indispensible amino acids (Smuts and Marais, 1939). Due to lack of direct information the same course as previously adopted, namely supplementation by the least expensive and most easily procurable amino acid, was followed. Consequently sesamemeal and cottonseedmeal were each supplemented by cystine and compared with the unsupplemented component in a paired feeding test.

The supplementation of coprameal with 0·20 per cent. cystine showed no improvement in gains in weight over the unsupplemented coprameal ration (Smuts and Marais, 1939). It was therefore decided to test the inclusion of another indispensible amino acid namely lysine in a ration of which the nitrogen consisted entirely of coprameal protein.

Previous attempts (Smuts and Marais, 1938) to establish the nature of the amino acid deficiency of peanutmeal proved unsuccessful. The addition of tryptophane, lysine and cystine produced no significant response in growth. Five out of the six pairs of rats showed greater gains in weight, when cystine was added to the peanut ration. The magnitude of these gains was, however, too small to establish significance. Beach and White (1937) as well as Baernstein produced evidence that arachin, which constitutes four-fifths of the entire globulin of peanut, is deficient in methionine. On the other hand the remaining fraction of the peanut globulin, namely conarachin is, according to the latter author, an excellent protein for growth. It contains apparently sufficient methionine since it compares favourably with casein in growth-promoting properties. Kotasthane and Narayana (1937) conclude that peanutmeal compares better with milk proteins than soyabeans. All these contributions point strongly to a methionine deficiency in peanutmeal. In fact the evidence seemed so convincing that in a previous paper we assumed methionine to be the indispensible amino acid of peanutmeal. In order to verify our assumption, it was decided to supplement peanutmeal with methionine.

Both soyabeanmeal and linseedmeal have been found to be deficient in cystine. These results were established by the paired feeding method as well as by nitrogen balance studies (Smuts and Marais, 1938). However, it appeared that they may be deficient in a secondary amino acid. Consequently tryptophane was added to each of these meals already supplemented by cystine.

Under practical conditions bran is considered an excellent feed for almost every type of animal. From a scientific point of view, it seems as if this general experience is correct. The endosperm protein appears to be the least valuable, while the proteins of the embryo and aleurone cells are the most valuable. Mitchell (1938) found that whole wheat including the epidermis or bran portion has a biological value of 67 as compared with 52 for patent white flour of which the epidermis has been removed. Klein and associates has made a complete study of the whole wheat kernel. Jones (1937) in a study of the nutritional propeities of wheat proteins showed by chemical analysis that the cystine, arginine, histidine, lysine and tryptophane content of bran proteins are higher than that of the endosperm proteins. He furthei showed by feeding experiments that bran proteins gave a better growth with rats than white flour. Osborne and Mendel (1919) state " that wheat proteins considered in their entirety are adequate for promoting normal growth if eaten in sufficient amounts ". By means of feeding experiments wheat has been found to be deficient in lysine. In order to ascertain, if bran is not probably deficient in lysine, this amino acid was added to a bran ration and its effects on the growth of rats in paired feeding tests studied.

## EXPERIMENTAL.

All protein feeds were of commercial quality representative of those brands used in practical feeding. These meals were finely ground and mixed with the rest of the ingredients of the experimental ration so as to give approximately 9 per cent. protein. The amino acids were carefully mixed with the iest of the ration so as to ensure homogeneous distiibution. The percentage composition of the rations is given in Table 1.

The paired feeding method was utilized throughout these studies. The nitrogen balance sheet method of Mitchell was used for the determination of the biological values. Rats were paired according to age, sex, litter and weight. Body weights were taken weekly and the initial and final weights were the average of three consecutive weighings.

## DISCUSSION OF EXPERIMENTAL RESULTS.

In Table 2 is given the results on the paired feeding trial of sesamemeal and sesamemeal supplemented with 0·2 per cent. cystine. In a comparison of the weekly gains, as shown in Table 3, rats on sesamemeal supplemented by 0·2 per cent. cystine gained 37 times and those on the unsupplemented ration, only 9 times out of the 48 comparisons.

The supplemented ration gained in total weight over the unsupplemented in 4 out of the 6 pairs of rats. The mean gain between the six comparisons is 23 and the standard deviation 19·8. The value of Z in this case becomes 1·2. Applying Student's probability table for $Z = 1 \cdot 2$ and $N = 6$, the probability that the increase in weight registered by the addition of cystine was a chance effect is 1 in 45. This result, therefore, indicates that the inclusion of cystine has enhanced the growth-promoting properties of sesamemeal. However, the crucial point is whether the inclusion of cystine

### TABLE 1.

*Percentage Composition of Rations.*

| Ingredients. | A. | B. | C. | D. | E. | F. | G. | H. | I. | J. | K. | L. | M. | N. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sesamemeal | 23·0 | 22·6 | — | — | — | — | — | — | — | — | — | — | — | — |
| Wheat bran | — | — | — | — | — | — | — | — | — | — | 53·4 | 52·3 | — | — |
| Coprameal | — | — | — | — | 30·2 | 29·6 | — | — | — | — | — | — | — | — |
| Peanutmeal | — | — | — | — | — | — | — | — | — | — | — | — | 15·0 | 14·7 |
| Gottonseedmeal | — | — | 22·2 | 21·8 | — | — | — | — | — | — | — | — | — | — |
| Soyabeanmeal | — | — | — | — | — | — | 23·2 | 22·8 | — | — | — | — | — | — |
| Linseedmeal | — | — | — | — | — | — | — | — | 25·1 | 24·7 | — | — | — | — |
| Cystine | — | 0·2 | — | 0·2 | — | — | 0·2 | 0·2 | 0·2 | 0·2 | — | — | — | — |
| Lysine | — | — | — | — | — | 0·2 | — | — | — | — | — | 0·2 | — | — |
| Tryptophane | — | — | — | — | — | — | — | 0·15 | — | 0·15 | — | — | — | — |
| Methionine | — | — | — | — | — | — | — | — | — | — | — | — | — | 0·2 |
| Butterfat | 8·0 | 8·0 | 8·0 | 8·0 | 8·0 | 8·0 | 8·0 | 8·0 | 8·0 | 8·0 | 8·0 | 8·0 | 8·0 | 8·0 |
| Codliveroil | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 |
| Harris yeast | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 |
| Sucrose | 10·0 | 10·0 | 10·0 | 10·0 | 10·0 | 10·0 | 10·0 | 10·0 | 10·0 | 10·0 | 10·0 | 10·0 | 10·0 | 10·0 |
| * Salt mixture | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 | 2·0 |
| Na Cl | 1·0 | 1·0 | 1·0 | 1·0 | 1·0 | 1·0 | 1·0 | 1·0 | 1·0 | 1·0 | 1·0 | 1·0 | 1·0 | 1·0 |
| Starch (Dextrinized) | 52·0 | 52·2 | 52·8 | 53·0 | 44·8 | 45·2 | 51·6 | 51·85 | 49·7 | 49·95 | 21·6 | 22·5 | 60·0 | 60·1 |
| Total | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 |
| Per cent. Nitrogen | 1·50 | 1·51 | 1·49 | 1·47 | 1·51 | 1·52 | 1·45 | 1·46 | 1·50 | 1·50 | 1·52 | 1·53 | 1·44 | 1·45 |

* New salt mixture of Hubbel, R., Mendel, T. B. and Wakeman, A. J. (J. Nutr. 14–273·285–1937).

### TABLE 2.

*Comparison between Sesame Meal and Sesame Meal + 0·2 per cent. Cystine.*

| | 1. | | 2. | | 3. | | 4. | | 5. | | 6. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sesame | Sesame and Cystine. | Sesame | Sesame and Cystine. | Sesame | Sesame and Cystine. | Sesame | Sesame and Cystine. | Sesame | Sesame and Cystine. | Sesame | Sesame and Cystine. |
| Initial weight, gm. | 115 | 111 | 109 | 108 | 115 | 116 | 117 | 118 | 104 | 105 | 104 | 104 |
| Final weight, gm. | 175 | 202 | 154 | 202 | 192 | 190 | 190 | 187 | 170 | 199 | 150 | 187 |
| Gain, gm. | 60 | 91 | 45 | 94 | 77 | 74 | 73 | 69 | 66 | 94 | 46 | 83 |
| Food Consumption, gm. | 663 | 663 | 649 | 649 | 662 | 662 | 663 | 663 | 663 | 663 | 622 | 622 |
| Refusals | 0 | 0 | 13 | 0 | 0 | 1 | 1 | 5 | 0 | 0 | 10 | 0 |

has rendered the nitrogen of sesamemeal more utilizable for synthetic purposes. In Table 4 the data pertaining to the biological value determination of sesamemeal supplemented by cystine are given. In a previous paper by Smuts and Malan (1938) the biological value of sesamemeal at approximately the same level was determined and found to be 71. In Table 4 the biological value of sesamemeal supplemented by cystine was determined and a value of 80 obtained. Hence there was an increased nitrogen utilization of 9 per cent. This result, together with the paired feeding test, definitely establishes that the cystine addition to sesamemeal enhanced growth through a better utilization of the sesamemeal nitrogen.

TABLE 3.

*A Comparison of the Weekly Gains between Sesame and Sesame + 0·2 per cent. Cystine.*

| Weeks. | Pair 1. | Pair 2. | Pair 3. | Pair 4. | Pair 5. | Pair 6. | Total per Week. | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | + | – | ± |
| 1 | | | - | | | - | 0 | 6 | 0 |
| 2 | - | - | + | + | ± | – | 2 | 3 | 1 |
| 3 | — | | - | + | | - | 1 | 5 | 0 |
| 4 | | | + | + | + | – | 3 | 3 | 0 |
| 5 | | - | + | - | | | 1 | 5 | 0 |
| 6 | | - | + | – | – | – | 1 | 5 | 0 |
| 7 | | | | + | | | 1 | 5 | 0 |
| 8 | - | | ± | | | | 0 | 5 | 1 |
| | Total for Experiment | | | | | | 9 | 37 | 2 |

+ Indicates greater gain by Sesame meal.
- Indicates greater gain by Sesame meal + 0·2 per cent. Cystine.
± Indicates equal gains.

In the comparison of bran and bran supplemented by lysine, three pairs favour the bran ration and three the supplemented bran ration in total weight over the experimental period. In the weekly comparisons as shown in Table 6 the gains in weight are distributed almost equally amongst the two comparisons. Judging superficially there appears to be no difference in growth between the two comparisons. This assumption is borne out by a statistical analysis of the data. The mean gain in weight over the period of experimentation is 2·5 and the standard deviation 11·3, giving a value of 0·21 for Z. According to Student's probability table the odds are so small that chance alone may have brought about this result. Consequently, it must be concluded that the addition of lysine to bran had no effect on its growth-promoting properties and that it is not a limiting amino acid in bran protein.

## TABPE 4.

### *Biological Value of Sesame Meal +0·2 per cent. Cystine Ration. Nitrogen Metabolism Data and the Calculation of the Biological Value.*

### *N. Low Period.*

| Animal No. | Initial Weight. | Final Weight. | Average Weight. | Daily Food In-take. | Daily N. In-take. | Daily Fecal N. | Body N. in Feces. |  | Food N. in Feces. | Absor-bed. N. | Daily Uri-nary. N. | Body N. in Urine. |  | Food N. in urine. | Food N. Re-tained. | Biolo-gical Value. | App. Diges-tibi-lity. | True Diges-tibi-lity. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  | Per Gram. Food. | Per Day. |  |  |  | Per 100 gms. | Per Day. |  |  |  |  |  |
|  | gm. | gm. | gm. | gm. | mgm. | mgm. | mgm. | mgm. | mgm. | mgm. | mgm. | mgm. | mgm. | mgm. | mgm. |  |  |  |
| 1............ | 96 | 87 | 91·5 | 6·0 | — | 17·7 | 2·95 | — | — | — | 25·5 | 27·9 | — | — | — | — | — | — |
| 2............ | 94 | 87 | 90·5 | 6·4 | — | 17·2 | 2·69 | — | — | — | 24·5 | 27·1 | — | — | — | — | — | — |
| 3............ | 93 | 84 | 88·5 | 6·3 | — | 17·5 | 2·78 | — | — | — | 30·5 | 34·5 | — | — | — | — | — | — |
| 4............ | 106 | 100 | 103·0 | 7·0 | — | 20·3 | 2·90 | — | — | — | 20·4 | 19·8 | — | — | — | — | — | — |
| 5............ | 125 | 112 | 118·5 | 7·3 | — | 19·8 | 2·71 | — | — | — | 23·6 | 19·9 | — | — | — | — | — | — |
| 6............ | 104 | 92 | 99·0 | 8·2 | — | 20·6 | 2·51 | — | — | — | 22·3 | 22·5 | — | — | — | — | — | — |
| *Protein Period.* |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1............ | 125 | 130 | 127·5 | 10·0 | 151·0 | 44·0 | 2·95 | 29·5 | 14·5 | 136·5 | 54·5 | 27·9 | 35·6 | 18·8 | 117·7 | 86 | 71 | 90 |
| 2............ | 109 | 119 | 114·0 | 9·4 | 141·9 | 44·4 | 2·69 | 25·3 | 19·1 | 122·8 | 53·6 | 27·1 | 30·9 | 22·7 | 100·1 | 82 | 69 | 87 |
| 3............ | 119 | 127 | 123·0 | 10·0 | 151·0 | 39·2 | 2·78 | 27·8 | 11·4 | 139·6 | 58·0 | 34·5 | 42·4 | 15·6 | 124·0 | 89 | 74 | 92 |
| 4............ | 122 | 132 | 127·0 | 10·0 | 151·0 | 42·4 | 2·90 | 29·0 | 13·4 | 137·6 | 58·0 | 19·8 | 25·1 | 32·9 | 104·7 | 76 | 72 | 91 |
| 5............ | 149 | 149 | 149·0 | 9·7 | 146·5 | 46·0 | 2·71 | 26·3 | 19·7 | 126·8 | 62·0 | 19·9 | 29·6 | 32·4 | 94·4 | 74 | 68 | 87 |
| 6............ | 122 | 125 | 123·5 | 10·0 | 151·0 | 45·6 | 2·51 | 25·1 | 20·5 | 130·5 | 61·2 | 22·5 | 28·1 | 33·1 | 97·4 | 75 | 70 | 86 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Average . | 80 | 71 | 89 |

TABLE 5.

*Comparison between Wheat Bran and Wheat Bran* +0·2 *per cent.* Lysine.

| | 1. | | 2. | | 3. | | 4. | | 5. | | 6. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Wheat bran. | Wheat bran and lysine. | Wheat bran. | Wheat bran and lysine. | Wheat bran. | Wheat bran and lysine. | Wheat bran. | Wheat bran and lysine. | Wheat bran. | Wheat bran and lysine. | Wheat bran. | Wheat bran and lysine. |
| **Initial weight, gm.** | 70 | 71 | 62 | 63 | 87 | 88 | 90 | 87 | 75 | 79 | 74 | 73 |
| **Final weight, gm.** | 141 | 137 | 149 | 144 | 147 | 157 | 150 | 167 | 155 | 160 | 162 | 148 |
| **Gain, gm.** | 71 | 66 | 87 | 81 | 60 | 69 | 60 | 80 | 80 | 81 | 88 | 75 |
| **Food consumption, gm.** | 598 | 598 | 605 | 605 | 589 | 589 | 605 | 605 | 597 | 597 | 609 | 609 |
| **Refusals** | 2 | 4 | 1 | 6 | 8 | 0 | 3 | 0 | 4 | 3 | 0 | 4 |

TABLE 6.

*A Comparison of the Weekly Gains between Wheat Bran and Wheat Bran* +0·2 *per cent. Lysine.*

| Weeks. | Pair 1. | Pair 2. | Pair 3. | Pair 4. | Pair 5. | Pair 6. | Total per Week. | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | + | − | ± |
| 1 | ± | ± | + | + | − | + | 3 | 1 | 2 |
| 2 | ± | ± | − | − | + | + | 2 | 2 | 2 |
| 3 | + | + | ± | + | + | + | 5 | 0 | 1 |
| 4 | + | | − | − | − | ± | 1 | 4 | 1 |
| 5 | − | − | − | − | − | ± | 0 | 5 | 1 |
| 6 | + | | − | − | ± | + | 2 | 3 | 1 |
| 7 | + | + | − | | − | + | 3 | 3 | 0 |
| 8 | − | + | + | − | + | − | 3 | 3 | 0 |
| | Total for Experiment | | | | | | 19 | 21 | 8 |

+ Indicates greater gain by Wheat Bran.
− Indicates greater gain by Wheat Bran + 0·2 per cent. Lysine.
± Indicates equal gains.

In Table 7 the results of the paired feeding test on coprameal and coprameal supplemented by 0·2 per cent. lysine are reproduced. From the total gains in weight of the six pairs of rats, it will be seen that four of the 6 pairs showed a better gain on the supplemented ration.

However, the magnitude of these gains are extremely small, so much so that no statistical significance could be established. The mean gain in weight is 0·66 and the standard deviation, 4·8, making the outcome of this test completely insignificant. Hence, under these conditions, it appears as if lysine is not a limiting factor of coprameal.

In Table 9 the total gains in weight of the comparison between peanutmeal and peanutmeal supplemented by methionine, are summarized. Four pairs favour the supplemented and two pairs the unsupplemented ration in total gains. By analysing the results statistically, it is found that the mean gain in weight is 3·3 and the standard deviation 6·2. The value of Z becomes 0·53. According to Student's table of probability the odds are approximately 1 in 5 that chance alone may have brought about this result. On this basis it must be concluded that methionine addition did not contribute anything to the growth-promoting properties of peanutmeal.

It is interesting in this respect to refer to a previous publication by Smuts and Marais (1938) where peanutmeal was supplemented with cystine. In that case, although 5 out of the 6 pairs favoured the cystine supplementation, the magnitude of the gains was so small that the outcome was completely insignificant. These results would seem to indicate that peanutmeal contains enough cystine and methionine or methionine alone for the growth of the white rat. This would mean that while the greater portion of the globulin in peanut is deficient in methionine, the rest of the protein fraction is capable of supplying the needs of this amino acid for the growth of the rat.

On the other hand, it may be equally possible that minute quantities of methionine such as is present for instance in the conarachin fraction of peanuts, are sufficient in the presence of adequate cystine to promote normal growth. Under these conditions, it must be assumed that cystine can replace a certain portion of methionine in the process of anabolism.

Cottonseed gave the highest biological value of the natural plant proteins thus far investigated (Smuts and Malan, 1938). The indications are that in all probability, it is not seriously lacking in any particular indispensible amino acid. Nevertheless the effect of cystine supplementation was studied. The results on total gains and weekly gains are given in Tables 11 and 12.

TABLE 7.

*Comparison between Copra Meal and Copra Meal +0·2 per cent. Lysine.*

| | Copra Meal. | Copra Meal and Lysine. | Copra Meal. | Copra Meal and Lysine. | Copra Meal. | Copra Meal and Lysine. | Copra Meal. | Copra Meal and Lysine. | Copra Meal. | Copra Meal and Lysine. | Copra Meal. | Copra Meal and Lysine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Initial weight, gm.** | 102 | 100 | 109 | 107 | 80 | 82 | 114 | 116 | 126 | 120 | 48 | 50 |
| **Final weight, gm.** | 149 | 150 | 158 | 150 | 113 | 118 | 168 | 164 | 164 | 164 | 80 | 86 |
| **Gain, gm.** | 47 | 50 | 49 | 43 | 33 | 36 | 54 | 48 | 38 | 44 | 32 | 36 |
| **Food Consumption, gm.** | 394 | 394 | 394 | 394 | 331 | 336 | 394 | 394 | 394 | 394 | 272 | 272 |
| **Refusals** | 0 | 0 | 0 | 0 | 12 | 8 | 0 | 0 | 0 | 0 | 11 | 10 |

TABLE 8.

*A Comparison of Weekly Gains between Copra Meal and Copra Meal +0·2 per cent. Lysine.*

| Weeks. | Pair 1. | Pair 2. | Pair 3. | Pair 4. | Pair 5. | Pair 6. | Total per Week. | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | + | — | ± |
| 1 | — | — | — | + | — | — | 1 | 5 | 0 |
| 2 | — | — | + | ± | — | ± | 1 | 3 | 2 |
| 3 | + | + | — | + | ± | + | 4 | 1 | 1 |
| 4 | + | + | + | + | — | + | 5 | 1 | 0 |
| 5 | + | + | — | ± | + | — | 3 | 2 | 1 |
| | Total for Experiment | | | | | | 14 | 12 | 4 |

+ Indicates greater gain by Copra meal.
— Indicates greater gain by Copra meal + 0·2 per cent. Lysine.
± Indicates equal gains.

TABLE 9.

*Comparison between Peanut Meal and Peanut Meal +0·2 per cent. Methionine.*

| | 1. | | 2. | | 3. | | 4. | | 5. | | 6. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Peanut. | Peanut + Methionine. | Peanut. | Peanut + Methionine. | Peanut. | Peanut + Methionine. | Peanut. | Peanut + Methionine. | Peanut. | Peanut + Methionine. | Peanut. | Peanut + Methionine. |
| Initial weight, gm.... | 63 | 64 | 67 | 64 | 62 | 60 | 65 | 66 | 68 | 68 | 63 | 63 |
| Final weight, gm..... | 110 | 115 | 135 | 140 | 105 | 95 | 134 | 142 | 130 | 128 | 128 | 138 |
| Gains, gm........... | 47 | 51 | 68 | 76 | 43 | 35 | 69 | 76 | 62 | 60 | 65 | 75 |
| Food Consumption, gm. | 430 | 430 | 544 | 544 | 423 | 423 | 541 | 541 | 516 | 516 | 543 | 543 |
| Refusals............. | 1 | 19 | 1 | 2 | 5 | 24 | 2 | 2 | 2 | 14 | 2 | 0 |

TABLE 10.

*A Comparison of the Weekly Gains between Peanut and Peanut +0·2 per cent. Methionine.*

| Weeks. | Pair 1. | Pair 2. | Pair 3. | Pair 4. | Pair 5. | Pair 6. | Total per Week. | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | + | — | ± |
| 1........... | — | ± | — | — | — | — | 0 | 5 | 1 |
| 2........... | — | + | ± | + | + | — | 3 | 2 | 1 |
| 3........... | + | + | + | — | + | — | 3 | 2 | 1 |
| 4........... | + | | + | ± | — | + | 3 | 2 | 1 |
| 5........... | + | ± | + | | + | | 3 | 2 | 1 |
| 6........... | — | — | — | — | — | — | 0 | 6 | 0 |
| 7........... | + | | + | + | ± | — | 3 | 2 | 1 |
| 8........... | — | | + | | + | + | 3 | 3 | 0 |
| Total for Experiment . . ... | | | | | | | 18 | 24 | 6 |

+ Indicates greater gain by peanut meal.
— Indicates greater gain by peanut meal + 0·2 per cent. Methionine.
± Indicates equal gain.

TABLE 11.

*Comparison between Cottonseed and Cottonseed +0·2 per cent. Cystine.*

| | 1. | | 2. | | 3. | | 4. | | 5. | | 6. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cotton-seed. | Cotton-seed + Cystine. | Cotton-seed. | Cotton-seed + Cystine. | Cotton-seed. | Cotton-seed + Cystine. | Cotton-seed. | Cotton-seed + Cystine. | Cotton-seed. | Cotton-seed + Cystine. | Cotton-seed. | Cotton-seed + Cystine. |
| **Initial weight, gm.** | 95 | 95 | 116 | 118 | 108 | 109 | 121 | 121 | 127 | 128 | 135 | 132 |
| **Final weight, gm.** | 167 | 186 | 185 | 186 | 163 | 182 | 185 | 184 | 167 | 190 | 192 | 190 |
| **Gain, gm.** | 72 | 91 | 69 | 68 | 55 | 73 | 64 | 63 | 40 | 62 | 57 | 58 |
| **Food Consumption, gm.** | 664 | 664 | 638 | 638 | 648 | 648 | 648 | 648 | 646 | 646 | 648 | 648 |
| **Refusals** | 0 | 2 | 1 | 12 | 0 | 7 | 2 | 3 | 8 | 0 | 8 | 0 |

TABLE 12.

*A Comparison of the Weekly Gains between Cottonseed and Cotton seed +0·2 per cent. Cystine.*

| Weeks. | Pair 1. | Pair 2. | Pair 3. | Pair 4. | Pair 5. | Pair 6. | Total per Week. | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | + | — | ± |
| 1 | + | + | — | ± | + | + | 4 | 1 | 1 |
| 2 | — | — | — | ± | — | + | 1 | 4 | 1 |
| 3 | — | — | — | — | — | — | 0 | 6 | 0 |
| 4 | — | + | + | + | — | ± | 3 | 2 | 1 |
| 5 | — | — | — | — | — | — | 0 | 6 | 0 |
| 6 | — | + | ± | + | — | + | 3 | 2 | 1 |
| 7 | — | — | — | ± | — | ± | 0 | 4 | 2 |
| 8 | — | + | — | — | — | — | 1 | 5 | 0 |
| | Total for Experiment | | | | | | 12 | 30 | 6 |

+ Indicates greater gain by Cottonseed.
— Indicates greater gain by Cottonseed + 0·2 per cent. Cystine.
± Indicates equal gains.

## TABLE 13.

### *Biological Value of Cottonseed +0·2 per cent. Cystine Ration. Nitrogen Metabolism Data and the Calculation of the Biological Value.*

*N. Low Period.*

| Animal No. | Initial Weight. | Final Weight. | Average Weight. | Daily Food Intake. | Daily N. Intake. | Daily Fecal N. | Body N. in Feces. |  | Food N. Per Feces. | Absorbed. N. | Daily Urinary N. | Body N. in Urine. |  | Food N. in Urine. | Food N. Retained. | Biological Value. | App. Digestibility. | True Digestibility. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  | Per gram Food. | Per Day. |  |  |  | Per 100 gms. | Per Day. |  |  |  |  |  |
|  | gm. | gm. | gm. | gm. | mgm. | mgm. | mgm. | mgm. | mgm. | mgm. | mgm. | mgm. | mgm. | mgm. | mgm. |  |  |  |
| 1............ | 85 | 84 | 85 | 6·5 | — | 18·4 | 2·83 | — | — | — | 10·5 | 12·4 | — | — | — | — | — | — |
| 2............ | 124 | 126 | 125 | 9·3 | — | 25·5 | 2·74 | — | — | — | 14·7 | 11·8 | — | — | — | — | — | — |
| 3............ | 137 | 135 | 136 | 9·9 | — | 30·7 | 3·10 | — | — | — | 14·1 | 10·4 | — | — | — | — | — | — |
| 4............ | 102 | 100 | 101 | 7·4 | — | 23·8 | 3·22 | — | — | — | 16·6 | 16·4 | — | — | — | — | — | — |
| 5............ | 136 | 135 | 136 | 8·9 | — | 25·0 | 2·81 | — | — | — | 13·9 | 10·2 | — | — | — | — | — | — |
| 6............ | 129 | 130 | 130 | 9·2 | — | 25·7 | 2·79 | — | — | — | 17·0 | 13·1 | — | — | — | — | — | — |

*Protein Period.*

| Animal No. | Initial Weight. | Final Weight. | Average Weight. | Daily Food Intake. | Daily N. Intake. | Daily Fecal N. | Body N. in Feces. Per gram Food. | Body N. in Feces. Per Day. | Food N. Per Feces. | Absorbed. N. | Daily Urinary N. | Body N. in Urine. Per 100 gms. | Body N. in Urine. Per Day. | Food N. in Urine. | Food N. Retained. | Biological Value. | App. Digestibility. | True Digestibility. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1............ | 113 | 123 | 118 | 9·5 | 139·7 | 44·0 | 2·83 | 26·9 | 17·1 | 122·6 | 32·7 | 12·4 | 14·6 | 18·1 | 104·5 | 85·2 | 68·5 | 87·8 |
| 2............ | 149 | 160 | 155 | 11·0 | 161·7 | 48·7 | 2·74 | 30·1 | 18·6 | 143·1 | 43·3 | 11·8 | 18·3 | 25·0 | 118·1 | 82·5 | 69·9 | 88·5 |
| 3............ | 160 | 160 | 160 | 9·3 | 136·7 | 42·8 | 3·10 | 28·8 | 14·0 | 122·7 | 31·8 | 10·4 | 16·6 | 15·2 | 107·5 | 87·6 | 61·4 | 89·8 |
| 4............ | 133 | 136 | 135 | 9·3 | 136·7 | 47·7 | 3·22 | 29·9 | 17·8 | 118·9 | 31·8 | 16·4 | 22·1 | 9·7 | 109·2 | 91·8 | 65·1 | 87·0 |
| 5............ | 159 | 168 | 164 | 8·9 | 130·8 | 44·8 | 2·81 | 25·0 | 19·8 | 111·0 | 41·8 | 10·2 | 16·7 | 25·1 | 85·9 | 77·4 | 65·7 | 84·9 |
| 6............ | 160 | 168 | 164 | 10·7 | 157·3 | 51·9 | 2·79 | 29·9 | 22·0 | 135·3 | 48·2 | 13·1 | 21·5 | 26·7 | 108·6 | 80·3 | 67·0 | 86·0 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | Average... |  | 84·1 | 66·3 | 86·3 |

### TABLE 14.

*Comparison between Soyabeans +0·2 per cent. Cystine and Soyabeans +0·2 per cent. Cystine +0·15 per cent. Tryptophane.*

| | 1. | | 2. | | 3. | | 4. | | 5. | | 6. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Soyabeans + Cystine. | Soyabeans + Cystine + Tryptophane. | Soyabeans + Cystine. | Soyabeans + Cystine + Tryptophane. | Soyabeans + Cystine. | Soyabeans + Cystine + Tryptophane. | Soyabeans + Cystine. | Soyabeans — Cystine + Tryptophane. | Soyabeans + Cystine. | Soyabeans + Cystine + Tryptophane. | Soyabeans + Cystine. | Soyabeans + Cystine + Tryptophane. |
| **Initial weight, gm.** | 67 | 64 | 75 | 72 | 99 | 98 | 105 | 106 | 108 | 103 | 91 | 92 |
| **Final weight, gm.** | 75 | 65 | 130 | 122 | 100 | 119 | 114 | 107 | 156 | 121 | 138 | 138 |
| **Gain, gm.** | 8 | 1 | 55 | 50 | 1 | 21 | 9 | 1 | 48 | 18 | 47 | 46 |
| **Food Consumption, gm.** | 323 | 323 | 508 | 508 | 415 | 415 | 317 | 317 | 419 | 419 | 421 | 421 |
| **Refusals** | 4 | 32 | 3 | 5 | 13 | 0 | 9 | 10 | 0 | 27 | 0 | 2 |

### TABLE 15.

*A Comparison of the Weekly Gains between Soyabeans +0·2 per cent. Cystine and Soyabeans +0·2 per cent. Cystine +0·15 per cent. Tryptophane.*

| Weeks. | Pair 1. | Pair 2. | Pair 3. | Pair 4. | Pair 5. | Pair 6. | Total per Week. | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | + | — | ± |
| 1 | ± | + | — | + | | .. | 2 | 2 | 1 |
| 2 | ± | — | — | + | + | .. | 2 | 2 | 1 |
| 3 | — | ± | + | ± | — | — | 1 | 3 | 2 |
| 4 | + | ± | — | + | + | — | 3 | 2 | 1 |
| 5 | ± | — | ± | + | + | + | 3 | 1 | 2 |
| 6 | + | + | — | + | + | + | 5 | 1 | 0 |
| 7 | + | — | — | .. | — | + | 2 | 3 | 0 |
| 8 | ± | + | + | .. | + | ± | 3 | 0 | 2 |
| | Total for Experiment | | | | | | 21 | 14 | 9 |

Indicates greater gain by Soyabeans + 0·2 per cent. Cystine.
Indicates greater gain by Soyabeans + 0·2 per cent. Cystine + 0·15 per cent. Tryptophane.
Indicates equal gain.

## TABLE 16.

*Comparison between Linseed* +0·2 *per cent. Cystine and Linseed* +0·2 *per cent. Cystine* +0·15 *per cent. Tryptophane.*

| | 1. | | 2. | | 3. | | 4. | | 5. | | 6. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Linseed +Cystine. | Linseed + Cystine + Trypto-phane. | Linseed +Cystine. | Linseed + Cystine + Trypto-phane. | Linseed +Cystine. | Linseed + Cystine + Trypto-phane. | Linseed +Cystine. | Linseed + Cystine + Trypto-phane. | Linseed +Cystine. | Linseed + Cystine + Trypto-phane. | Linseed +Cystine. | Linseed + Cystine + Trypto-phane. |
| **Initial weight, gm....** | 99 | 99 | 97 | 93 | 87 | 85 | 84 | 84 | 84 | 86 | 86 | 83 |
| **Final weight, gm.....** | 189 | 180 | 192 | 178 | 158 | 158 | 155 | 147 | 165 | 173 | 148 | 137 |
| **Gain, gm............** | 90 | 81 | 95 | 85 | 71 | 73 | 71 | 63 | 81 | 87 | 62 | 54 |
| **Food Consumption, gm.** | 579 | 579 | 599 | 599 | 519 | 519 | 520 | 520 | 547 | 547 | 475 | 475 |
| **Refusals.............** | 0 | 6 | 0 | 1 | 8 | 0 | 11 | 12 | 14 | 0 | 14 | 16 |

## TABLE 17.

*A Comparison of the Weekly Gains between Linseed* +0·2 *per cent. Cystine and Linseed* +0·2 *per cent. Cystine* +0·15 *per cent. Tryptophane.*

| Weeks. | Pair 1. | Pair 2. | Pair 3. | Pair 4. | Pair 5. | Pair 6. | Total per Week. | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | + | — | ± |
| 1................... | ± | + | + | + | + | + | 5 | 0 | 1 |
| 2................... | — | + | — | — | — | — | 1 | 0 | 5 |
| 3................... | ± | + | + | + | — | + | 4 | 1 | 1 |
| 4................... | + | — | ± | + | ± | — | 2 | 2 | 2 |
| 5................... | — | — | — | + | — | + | 2 | 4 | 0 |
| 6................... | + | — | — | — | ± | + | 2 | 2 | 1 |
| 7................... | + | + | — | + | — | + | 4 | 2 | 0 |
| 8................... | + | — | — | + | ± | + | 3 | 2 | 1 |
| | Total for Experiment................ | | | | | | 23 | 14 | 11 |

+ Indicates greater gain by Linseed + 0·2 per cent. Cystine.
— Indicates greater gain by Linseed + 0·2 per cent. Cystine + 0·15 per cent. Tryptophane.
± Indicates equal gain.

Out of the six pairs in the comparison four showed an increased weight on the supplemented ration. The mean difference in total weight is equal to 9·6 and the standard deviation 10·2, giving a value equal to 0·94. The odds that the increase in weight was due to the cystine supplementation are 22 to 1. Consequently it must be concluded that the addition of cystine to cottonseed meal had no effect on the growth-promoting properties of the latter. In Table 13 the biological value of cottonseedmeal plus cystine was determined. As will be seen from these figures an average value of 84 was obtained. In a previous paper Smuts and Malan (1938) found a biological value for cottonseedmeal at approximately the same level of intake of 81. These two values are very nearly the same with no apparent significant difference in the nitrogen utilization. It appears therefore as if cystine is not a limiting amino acid in cottonseed protein.

Both soyabeans and linseedmeal have previously been found to be deficient in cystine. Consequently the possibility of a secondary amino acid deficiency was tested out. Both these protein feeds were therefore supplemented by tryptophane in addition to cystine and compared with the cystine supplementation. The results on soyabeans are given in Table 14 and 15 and that of linseedmeal in Tables 16 and 17. In neither case did the tryptophane addition enhance the growth promoting properties. In fact with linseedmeal the tryptophane addition had, if anything, a slight depressing effect.

## SUMMARY AND CONCLUSIONS.

By means of paired feeding tests, it has been shown that sesamemeal is deficient in cystine and that cottonseedmeal is not deficient in this amino acid. Bran and coprameal are apparently not deficient in lysine, while the supplementation of peanutmeal with methionine did not enhance its growth-promoting properties. Tryptophane does not appear to be a secondary amino acid deficiency in either soyabeans or linseedmeal.

By means of nitrogen balance studies, it was shown that the increased weights obtained by the supplementation of sesamemeal with cystine are due to a better utilization of the sesamemeal nitrogen. The unsupplemented biological value previously determined by Smuts and Malan was 71 and the supplemented biological value as determined in this paper 80. In thecase of cottonseed supplemented by cystine, the biological value of 84 is only slightly higher than 81, and does not signify a significantly better utilization of nitrogen of the supplemented over the unsupplemented cottonseedmeal.

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# The Dry Matter Consumption of Sheep on Natural Grazing in the Transvaal.

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ONE of the major problems with which the sheep and cattle industry of the summer rainfall areas is continually confronted, is the tremendous loss in weight of animals during the winter months. This progressive decline in weight becomes even more complicated, when it is realized that the prevailing phosphorus deficiency of the pasture during winter is not exclusively responsible for this abnormal phenomenon of weight reduction. In fact it has been shown on numerous occasions that the administration of phosphates or phosphatic licks alone does not remedy this condition. It would, therefore, appear as if the whole question of weight loss is either due to a complex nutritional deficiency or to an inadequate food consumption which may be associated with the fibrous and highly lignified state of the winter pasture. However, these assumptions are at present mere speculations and can only be settled one way or another by a systematic analysis of the entire problem as it appears in practice. It is also clear, that whatever method of attack is employed, one common and insurmountable factor, namely, the estimation of the amount of grazing consumed per day, remains an obstacle in the ultimate and final solution of this very important economic problem. Thus to show conclusively and in a scientific manner that either protein, phosphorus, energy or the entire complex is deficient in winter grazing, it seems imperative that the amount of grazing consumed, the quantities of these elements present as well as their utilizability by the animal, should be known. On this basis alone can the magnitude of such a deficiency be determined and scientifically rectified. Other methods of establishing nutritional deficiencies, such as differences in gain in weight between supplemented and unsupplemented rations or changes in the chemical composition of the blood or tissues, merely indicate the possibility that such a deficiency exists, but neglect the basic information of total intake and utilizability without which scientific and economic supplementation of the deficient element become mere approximation.

Apparently little attention has been given to this aspect of work in the past. Recently, however, Garrigus and Rusk have measured the dry matter consumption of steers on reed canary and brome grasses. Their method consisted in determining the daily dry matter of the faeces voided and the percentage digestibility of the dry matter of these grasses. From these figures they could then calculate the dry matter consumed by their animals. Woodman and Evans on the other hand utilized the organic matter of the faeces and the percentage digestibility of the latter elements to measure the grass consumption of their sheep. We have adopted the method of Garrigus and Rusk for our work.

## EXPERIMENTAL.

The experiment to be described was conducted at the Ermelo Experimental Station. The general conditions at this station in respect of rainfall, growth of pasture and seasonal fluctuations in protein content of the natural flora are fairly representative of the entire Transvaal. Twenty sheep belonging to a grazing flock were utilized for this work. In order to maintain the natural conditions of grazing, these sheep were not separated from the rest of the flock. At the start of each collection period, specially constructed metabolism bags, which fitted tightly round the hindquarters of the sheep, were put on to each sheep two days prior to the actual collection. This preliminary period was essential to accustom the sheep to the metabolism bags and prevent unusual restlessness. After this preliminary period the sheep did not seem to take any notice of the metabolism bags and grazed about normally. The collection period proper was then started. The metabolism bags were put on early in the morning and changed during the late afternoon. For the purpose of changing the metabolism bags a temporary camp consisting of wire netting fixed to a few poles was constructed in the corner of the existing camp. The flock was then grazed slowly towards this temporary camp, and interned. With the help of two native assistants the experimental sheep were carefully separated from the rest of the flock and the metabolism bags removed, while others were immediately put on. As soon as all the bags were changed, the wire netting constituting the temporary camp was let down and the sheep allowed to graze. The metabolism bags containing the faeces were removed to the laboratory, where the faeces were spread out and allowed to sun-dry. The daily sun-dried faeces were then carefully weighed and 10 per cent. aliquots taken and stored in air-tight fruit jars. Total dry matter was then determined on a representative sample of the entire 10 days' aliquot. During the 10 days' collection period representative grazing was cut by following the grazing sheep. This grass was utilized for the metabolism studies and the determination of the digestibility of the dry matter. From the daily dry matter of the faeces and the digestibility of the dry matter the dry matter consumption was calculated.

Collection periods were so arranged as to take place during the different seasons of the year. Hence collections took place during January, April, July and October. In this way it was anticipated to obtain information on the plausibility of the assumption that sheep consume comparatively more grazing during summer than during the winter months.

## EXPERIMERTAL RESULTS.

In Table 1 is given the percentage digestibility of the dry matter of the grazing during the different seasons of the year. It will be noted from the data presented in the above table, that there is very little variation amongst the individual digestibility figures of the same period. Consequently it is only fair to assume that the average digestibility for the different periods is also representative of the natural grazing during those seasons of the year. On this basis, therefore, the mean dry matter digestibility of each period was utilized for the ultimate calculation of the dry matter consumed from the dry matter contained in the faeces.

It is interesting to note that during July, when the grazing is dry, fibrous and highly lignified, the protein content drops as low as 3·1 per cent. During this period the digestibility of the dry matter of the grazing also reaches its lowest level, namely 43 per cent. With the first summer rains and the beginning of the growing stage in October, the protein content of the natural flora increases rapidly to approximately 9·9 per cent. There is also a corresponding increase in the percentage digestibility of the dry matter during this month. During January there is apparently very little difference in the digestibility of the dry matter in comparison with that of October. The average figures are 58 and 60 respectively. As soon as winter conditions set in and the grazing becomes dry as happens in April, there is again a decided drop in both the protein content and the digestibility of the dry matter. The average percentage digestibility of 46 per cent. corresponds closely with the figure obtained during July.

In Tables 2, 3, 4 and 5 are reproduced the results relative to the calculation of the dry matter consumption of sheep during the different seasons of the year.

Several interesting points arise from a detailed consideration of the data. Thus it will be noticed, that the average daily weight of the sheep increases or decreases according to the protein content of the pasture and the season of the year. During the middle of winter as represented by our July figures the protein content of the pasture as well as the average weight of the animals are the lowest for the year. When the nitrogen content increases from 0·49 per cent. in July to 1·44 per cent. in October, there is also a corresponding increase in weight from 28 Kgms. to 33 Kgms. In January the nitrogen content is still fairly high and averages 1·17 per cent. The average weight of the sheep is at its best during this month and averages 40 Kgms. From January onwards the grazing matures fairly fast, so much so that the nitrogen content drops to 0·73 per cent. in April. This decided drop in nitrogen also reflects on the weight of the sheep. There is consequently a noticeable drop in weight to 39 Kgms. during April.

Another interesting feature is the fact that the dry matter excretion on grazing does not seem to bear any relation to the condition, stage of growth or to the seasonal fluctuations in protein content of the pasture. During October when the first blades of green grass appear and the pasture can therefore be assumed to be in its most palatable stage, the dry matter excretion is less than in July. The average figures for the two months are 324 and 370 grams respectively. Similarly the dry matter excretion during the more advanced state of maturity in April is higher than during January. In April the daily dry matter excretion is 465 grams daily, while it is only 363 grams in January.

A point of practical importance is the apparent relationship between dry matter consumption and the live weight of the animals. In July, when the average daily weight of the sheep was 28 Kgms. the dry matter consumption was at its lowest, namely 649 grams. As these sheep increased in weight to 33 Kgms. in October, the dry matter consumption also increased to 718 grams daily. In January, when the maximum average weight was attained, it was accompanied by a maximum dry matter consumption of 907 grams. During April the average weight of the sheep fell to 39 Kgms. This decrease in weight was associated with a corresponding decrease in dry matter consumption. These figures strongly indicated that the dry matter consumption of an animal may be related to body weight, power function of weight or surface area, in the same way as the maintenance protein requirement or the basal metabolism. On this basis the dry matter consumption for the different periods of measurement was expressed per kilogram body weight and per square meter of body surface as illustrated in columns 14 and 15 of the respective tables. In the latter case the surface area was calculated from the formula of Pierce and Linas namely, $S = {\cdot}121\ W^{\cdot 59}$. There is indeed very little difference between the average value for the different periods, when expressed in this manner. In July the average dry matter consumption per Kg. is 23·4 gram and 748 grms. per s.m. For October the average values are 23·7 and 823 grams. For January and April the values per Kg. are 22·7 and 22·2 and per sq. m. 840 and 823 grams respectively. The coefficient of variation never exceeds the 12 per cent. mark in any of the periods.

Kleiber concludes that as a working hypothesis the maximum food capacity of an animal can be regarded as a similar function of its weight as the basal metabolism. He further shows that the basal metabolism of different species of animals can best be related to the $\frac{3}{4}$ power function of its weight. On this basis he evolved the following general equation $B = 72W^{\frac{3}{4}}$ for calculating the basal metabolism of different species of animals.

We have adopted the Kleiber equation for relating dry matter consumption to body weight. The equation now reads $DM = k\ W^{\frac{3}{4}}$ where DM equals the dry matter in grams, k the constant varying in all probability with different conditions and W the weight in kilograms.

On this basis the value of k was determined for each period from the measured dry matter consumption and the respective weights of the animals. In column 8 of the respective tables the average constant for the different periods is given. Very significant is the fact that these constants for the different periods of measurement, representing extreme pastoral conditions, are almost of the same magnitude. Thus the constant obtained under July conditions is 54, for October 57, for January 56 and for April 55. By including the above constants in the Kleiber equation, the dry matter consumption was predicted from the weights of the animals and compared with the dry matter consumption actually determined in each period. In column 10 of the tables the percentage deviation has been calculated. From these figures it will be seen that the predicted figures agree extremely well with the determined values. The average percentage deviation in the July figures is ±9 per cent., in October ±9·8 per cent., in January ±8·8 per cent. and in April ±5 per cent.

These small variations together with the fact that the constants of the individual periods are very similar, opened the possibility of utilizing a common constant, for the general prediction of the dry matter consumption of grazing sheep over the year. In this way the average of the four constants was applied to the Kleiber equation and the predicted results compared with the determined value. This formula now reads as follows $DM = 56\,W^{\frac{3}{4}}$, where DM equals dry matter in grams, and W weight in kilograms. In column 11 of the respective tables are given the predicted values of the daily dry matter consumption, according to the above formula. In column 12 these values are compared with the determined values and the percentage deviation determined. As will be seen the average percentage deviation in July is ±11 per cent., in October ±9·5 per cent., in January ±8·8 per cent. and in April ±5·2 per cent. The average deviation from all the periods is only ±9 per cent. This deviation is extremely small when compared with such biological constants as basal metabolism and the endogenous nitrogen.

## DISCUSSION OF RESULTS.

From the results of this investigation, it is evident that while the average daily dry consumption varies with the season of the year, and consequently with the protein content of the pasture, it is extremely constant when expressed per unit of weight, per $\frac{3}{4}$ power function of the weight or per sq. meter of body surface. From these data it would further appear as if the capacity for dry matter consumption is related in the same manner as the basal metabolism, to the surface area or $\frac{3}{4}$ power function of the weight. This would mean, that there is no justification to assume that sheep eat proportionately more per unit of weight of the summer grazing than of the winter grazing. In fact it appears as if the weight of the animal is the dominating factor and not the condition of the grazing. This interpretation would, therefore, favour the argument, that the loss in weight associated with winter grazing is definitely not due to the fact that sheep consume less winter grazing but justifies the view that the winter grazing is nutritionally inferior to the summer grazing. In other words the nutritional deficiencies in the winter grazing are so great that the same quantity of winter grazing per unit of weight cannot satisfy the requirements of the animals in the same efficient manner as the summer grazing. It can therefore be regarded as an established fact, that the periodic decline in weight of animals during winter is associated with a deficiency of certain essential nutritive elements in the winter grazing.

From a scientific aspect it is interesting that the dry matter consumption under natural grazing conditions should be as closely correlated with the power function of the weight of an animal as the basal metabolism and endogenous nitrogen. The $\frac{3}{4}$ power function of the weight of an animal is in all probability a very representative measure of the protoplasmic mass, which regulates the intensity of the basal metabolism as well as the endogenous nitrogen and may equally be responsible for the regulation of the appetite of an animal or in other words its feeding capacity. It is quite possible that both the basal metabolism and the endogenous nitrogen may be lowered during the winter months. In fact a few preliminary measurements of the endogenous nitrogen under conditions similar to those of the winter grazing conditions indicate strongly that such is the case. It can therefore readily be appreciated, that the lowered intensity of the protoplasmic reactions to conserve as far as is possible its own tissues, becomes a biological necessity. This natural condition of economic conservation, through a lowering of the intensity of the protoplasmic reactions may in all probability also be extended to the appetite or food capacity of the animal and indirectly to its live-weight.

Whatever the explanation may be for this striking correlation between weight and dry matter consumption, it is nevertheless of practical importance that the dry matter consumption under grazing conditions can readily be calculated from the weight of the animals. Whether the established equation will hold true under all conditions of grazing, and which factors may influence its general applicability, is a problem of the future. However, for comparative purposes it is interesting to compare the results of Garrigus and Rusk and Woodman and Evans obtained under quite different conditions. According to our formula a 100-pound sheep would eat 981 grams of dry matter. Woodman finds that a sheep of 131 pounds would consume approximately 3·01 pounds of dry matter. 'On the basis of a 100 lb., such a sheep would consume 1,044 grams of dry matter. Garrigus and Rusk finds that a 600-lb. steer would consume approximately 13 lb. dry matter which is equivalent to 989 grams per 100 lb. Our calculated value of 981 grams per 100 lb. differs by 63 grams from Woodman's value and with 18 grams from the average value of Garrigus. It would therefore seem as if the relationship between dry matter consumption and weight holds good for steers as well as sheep under unrestricted conditions of natural grazing.

## SUMMARY AND CONCLUSIONS.

From a study on the dry matter consumption of sheep under natural conditions of grazing, it is evident that the quantity consumed is not a factor in the loss of weight in sheep during winter. It appears from these data that the decline in weight is specifically due to a rapid depletion of nutritive elements from summer to winter grazing. It has further been shown that the dry matter consumption of sheep is correlated with the weight of the animals and that it can be predicted with success from the following equation $DM = 56W^{\frac{3}{4}}$, where DM equals dry matter in grams and W weight in Kilograms.

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## TABLE 1.

*Digestibility of Dry Matter during Different Seasons of the Year.*

| Animal No. | Weight. | Dry Matter Intake. | Dry Matter In Faeces. | Digestibility of Dry Matter. |
|---|---|---|---|---|
| | | JULY, 1938—0·49 PER CENT N. | | |
| | Kilogram. | Grams. | Grams. | Per cent. |
| 1 | 46 | 448 | 257 | 43 |
| 2 | 45 | 426 | 261 | 39 |
| 3 | 42 | 431 | 214 | 50 |
| 4 | 50 | 422 | 237 | 44 |
| 5 | 42 | 378 | 224 | 41 |
| AVERAGE | — | — | — | 43 |
| | | OCTOBER, 1938—1·44 PER CENT. N. | | |
| 38247 | 56 | 611 | 246 | 60 |
| 49612 | 53 | 723 | 336 | 54 |
| 38252 | 44 | 470 | 194 | 59 |
| 38243 | 48 | 602 | 253 | 58 |
| 39292 | 52 | 622 | 263 | 58 |
| AVERAGE | — | — | — | 58 |
| | | JANUARY, 1939—1·17 PER CENT. N. | | |
| 38248 | 32 | 515 | 211 | 59 |
| 49612 | 52 | 660 | 382 | 56 |
| 38252 | 42 | 573 | 225 | 61 |
| 38240 | 44 | 692 | 260 | 62 |
| 38000 | 45 | 469 | 171 | 64 |
| AVERAGE | — | — | — | 60 |
| | | APRIL, 1939—0·73 PER CENT. N. | | |
| 38248 | 43 | 430 | 218 | 49 |
| 49612 | 46 | 455 | 240 | 47 |
| 38252 | 41 | 427 | 240 | 44 |
| 38240 | 41 | 454 | 247 | 46 |
| 38249 | 40 | 326 | 179 | 45 |
| AVERAGE | — | — | — | 46 |

## TABLE 2.

*Data on the Grass Consumption of Sheep under Natural Conditions of Grazing.*

FIRST TEST, JULY, 1938.

| Animal No. | Weight | Daily Dry Weight Faeces. | Daily Dry Weight of Grass Consumed, D.M. | Log DM. | Log W. | W ¾. | Dm. = KW ¾. K | Dm. = 54 W ¾. | Percentage Deviation. | DM. = 56 W ¾. | Percentage Deviation | Surface Area S = ·121 $W^{\cdot 59}$ | DM. per Square Metre. | DM. per Kilo-Gram. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Kgm. | Gram. | Gram. | | | | | Gram. | | Gram. | | Sq. M. | Gram. | Gram. |
| 51689.......... | 26 | 337 | 951 | 2·7716 | 1·4150 | 11·5 | 51·4 | 622 | 5·2 | 645 | 9 | 0·827 | 715 | 22·7 |
| 51693.......... | 30 | 373 | 654 | 2·8156 | 1·4771 | 12·8 | 51·1 | 692 | 5·8 | 718 | 10 | 0·900 | 727 | 21·8 |
| 51694.......... | 26·5 | 425 | 746 | 2·8727 | 1·4232 | 11·7 | 63·8 | 631 | −15·4 | 654 | −12 | 0·836 | 892 | 28·2 |
| 51738.......... | 26·5 | 388 | 681 | 2·8331 | 1·4232 | 11·7 | 58·2 | 631 | − 7·3 | 654 | − 4 | 0·836 | 815 | 25·7 |
| 51755.......... | 26 | 406 | 712 | 2·8525 | 1·4150 | 11·5 | 61·9 | 622 | −12·6 | 645 | − 9 | 0·827 | 861 | 27·4 |
| 51757.......... | 26 | 343 | 602 | 2·7796 | 1·4150 | 11·5 | 52·3 | 622 | 3·3 | 645 | 7 | 0·827 | 728 | 23·2 |
| 51833.......... | 29 | 337 | 591 | 2·7716 | 1·4624 | 12·5 | 47·3 | 675 | 10·8 | 700 | 18 | 0·882 | 670 | 20·4 |
| 51863.......... | 28 | 404 | 709 | 2·8506 | 1·4472 | 12·3 | 58·2 | 666 | − 6·1 | 682 | − 4 | 0·864 | 821 | 25·3 |
| 51812.......... | 29 | 368 | 646 | 2·8102 | 1·4624 | 12·5 | 51·7 | 675 | 4·5 | 700 | − 8 | 0·882 | 733 | 22·3 |
| 51840.......... | 32 | 436 | 765 | 2·8837 | 1·5051 | 13·5 | 56·8 | 726 | − 5·1 | 753 | 2 | 0·935 | 818 | 23·9 |
| 51852.......... | 25·5 | 374 | 656 | 2·8169 | 1·4065 | 11·4 | 57·8 | 613 | − 6·6 | 635 | − 3 | 0·818 | 802 | 25·7 |
| 51885.......... | 23 | 248 | 435 | 2·3685 | 1·3617 | 10·3 | 41·4 | 567 | 30·3 | 588 | −35 | 0·770 | 565 | 18·9 |
| 51904.......... | 26 | 327 | 574 | 2·7589 | 1·4150 | 11·5 | 49·9 | 622 | 8·3 | 645 | 12 | 0·827 | 694 | 22·1 |
| 51924.......... | 26·5 | 277 | 486 | 2·6866 | 1·4232 | 11·7 | 41·5 | 631 | 29·8 | 654 | 34 | 0·836 | 581 | 18·3 |
| 52079.......... | 32 | 411 | 721 | 2·8579 | 1·5051 | 13·5 | 53·5 | 726 | 0·7 | 753 | 4 | 0·935 | 771 | 22·6 |
| 52010.......... | 26 | 355 | 623 | 2·7945 | 1·4150 | 11·5 | 54·1 | 622 | — | 645 | 4 | 0·827 | 753 | 23·9 |
| 52025.......... | 30 | 382 | 670 | 2·8261 | 1·4771 | 12·8 | 52·3 | 692 | 3·3 | 718 | 7 | 0·900 | 744 | 22·3 |
| 52100.......... | 31·5 | 381 | 668 | 2·8248 | 1·4983 | 13·5 | 50·2 | 735 | 10·0 | 745 | 12 | 0·927 | 721 | 21·2 |
| 52082.......... | 30 | 475 | 833 | 2·9206 | 1·4771 | 12·8 | 65·0 | 692 | −16·9 | 718 | −14 | 0·935 | 891 | 27·8 |
| 51765.......... | 25·5 | 355 | 623 | 2·7945 | 1·4065 | 11·4 | 54·9 | 613 | − 1·6 | 635 | 2 | 0·900 | 692 | 24·4 |
| Average........ | 28 | 370 | 649 | — | — | — | 54 | — | 9 | — | 11 | — | 748 | 23·4 |
| Standard Deviation.......... | — | — | — | — | — | — | — | — | — | — | — | — | 88 | 2·7 |
| Coef. of variation | — | — | — | — | — | — | — | — | — | — | — | — | 12 | 12 |

### TABLE 3.

### *Data on the Grass Consumption of Sheep under Natural Conditions of Grazing.*

SECOND TEST, OCTOBER, 1938.

| Animal No. | Weight | Daily Dry Weight Faeces. | Daily Dry Weight of Grass Consumed, D.M. | Log DM. | Log W. | W ¾. | Dm. = KW ¾. K. | Dm. = 54 W ¾. | Percentage Deviation. | DM. = 56 W ¾. | Percentage Deviation. | Surface Area $S = \cdot 121\ W^{\cdot 59}$ | DM. per Square Metre. | DM. per Kilo-Gram. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Kgm. | Gram. | Gram. | | | | | Gram. | | Gram. | | Sq. M. | Gram. | Gram. |
| 52082.......... | 36 | 405 | 964 | 2·9841 | 1·5563 | 14·7 | 65·6 | 838 | −13·3 | 823 | −15 | 1·002 | 962 | 26·7 |
| 51738.......... | 34 | 395 | 940 | 2·9731 | 1·5315 | 14·1 | 66·7 | 803 | −14·6 | 789 | −16 | 0·969 | 970 | 27·6 |
| 51885.......... | 32 | 352 | 838 | 2·9232 | 1·5051 | 13·5 | 62·3 | 767 | − 8·5 | 753 | −10 | 0·935 | 896 | 26·2 |
| 51757.......... | 33 | 361 | 860 | 2·9345 | 1·5185 | 13·8 | 62·4 | 785 | − 8·7 | 771 | −10 | 0·952 | 903 | 26·1 |
| 91904.......... | 33·5 | 348 | 829 | 2·9186 | 1·5250 | 13·9 | 59·8 | 794 | − 4·2 | 780 | − 6 | 0·961 | 863 | 24·7 |
| 52079.......... | 32 | 334 | 795 | 2·9004 | 1·5051 | 13·5 | 59·1 | 767 | − 3·5 | 753 | − 5 | 0·935 | 850 | 24·8 |
| 51765.......... | 29 | 269 | 640 | 2·8062 | 1·4624 | 12·5 | 51·2 | 713 | 11·4 | 700 | − 9 | 0·882 | 726 | 22·1 |
| 51833.......... | 36 | 251 | 836 | 2·9222 | 1·5563 | 14·7 | 56·9 | 838 | — | 823 | 2 | 1·002 | 834 | 23·2 |
| 51689.......... | 28·5 | 289 | 688 | 2·8376 | 1·4548 | 12·3 | 55·8 | 703 | 2·2 | 691 | — | 0·876 | 788 | 24·1 |
| 52100.......... | 37 | 297 | 707 | 2·8494 | 1·5682 | 14·1 | 47·1 | 855 | 20·9 | 840 | 19 | 0·995 | 711 | 19·1 |
| 51694.......... | 32 | 342 | 814 | 2·9016 | 1·5051 | 13·5 | 60·4 | 767 | − 5·8 | 753 | − 7 | 0·935 | 871 | 25·4 |
| 51755.......... | 29 | 317 | 755 | 2·8779 | 1·4624 | 12·5 | 60·3 | 713 | − 5·7 | 700 | − 7 | 0·882 | 856 | 26·0 |
| 51693.......... | 37·5 | 278 | 662 | 2·8209 | 1·5740 | 15·2 | 43·7 | 864 | 30·5 | 849 | 28 | 1·027 | 645 | 17·7 |
| 51852.......... | 34 | 322 | 767 | 2·8848 | 1·5315 | 14·1 | 54·5 | 803 | 4·7 | 789 | 3 | 0·969 | 792 | 22·6 |
| 52030.......... | 33·5 | 322 | 767 | 2·8848 | 1·5250 | 13·5 | 55·1 | 794 | 3·5 | 780 | 2 | 0·962 | 797 | 22·9 |
| 51840.......... | 35·5 | 344 | 819 | 2·9133 | 1·5502 | 14·5 | 56·3 | 829 | 1·2 | 815 | − 1 | 0·994 | 824 | 23·1 |
| 52010.......... | 29 | 257 | 612 | 2·7868 | 1·4624 | 12·5 | 46·8 | 713 | 16·5 | 700 | 14 | 0·882 | 694 | 21·1 |
| 52025.......... | 375 | 362 | 838 | 2·9232 | 1·5740 | 15·2 | 55·2 | 864 | 3·1 | 849 | 1 | 1·027 | 816 | 22·3 |
| Average........ | 33·0 | 324 | 718 | — | — | — | 57 | — | ± 9·8 | — | ± 9 | — | 823 | 23·7 |
| Standard Deviation.......... | — | — | — | — | — | — | — | — | — | — | — | — | 88 | 2·7 |
| Coef. Variation.. | — | — | — | — | — | — | — | — | — | — | — | — | 11 | 11·0 |

## TABLE 4.

## *Data on the Grass Consumption of Sheep under Natural Conditions of Grazing.*

THIRD TEST : JANUARY, 1939.

| Animal No. | Weight | Daily Dry Weight Faeces. | Daily Dry Weight of Grass Consumed, D.M. | Log DM. | Log W. | $W^{\frac{3}{4}}$. | Dm. = $KW^{\frac{3}{4}}$. K. | Dm. = 54 $W^{\frac{3}{4}}$. | Percentage Deviation. | DM. = 56 $W^{\frac{3}{4}}$. | Percentage Deviation. | Surface Area S=121 $W^{\cdot 59}$ | DM. per Square Metre. | DM. per Kilo-Gram. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Kgm. | Gram. | Gram. | | | | | Gram. | | Gram. | | Sq. M. | Gram. | Gram. |
| 51693.......... | 42 | 355 | 888 | 2·9484 | 1·6263 | 16·5 | 53·8 | 929 | 4·6 | 929 | 4·5 | 1·097 | 809 | 21·1 |
| 51694.......... | 43 | 413 | 1,033 | 3·0140 | 1·6335 | 16·8 | 61·5 | 940 | − 9·0 | 940 | − 9·0 | 1·114 | 927 | 24·0 |
| 51652.......... | 38 | 336 | 840 | 2·9243 | 1·5798 | 15·3 | 54·9 | 857 | 2·0 | 857 | 2·0 | 1·038 | 809 | 22·1 |
| 51738.......... | 41 | 421 | 953 | 2·9791 | 1·6128 | 16·2 | 58·7 | 907 | 4·8 | 907 | − 4·8 | 1·082 | 881 | 23·2 |
| 51757.......... | 37·5 | 322 | 805 | 2·9058 | 1·5740 | 15·2 | 52·9 | 849 | 5·5 | 849 | 5·5 | 1·027 | 784 | 21·5 |
| 51765.......... | 33·5 | 367 | 918 | 2·9628 | 1·5250 | 13·9 | 66·0 | 780 | 4·1 | 780 | 4·1 | 0·962 | 954 | 27·4 |
| 51833.......... | 43 | 382 | 955 | 2·9800 | 1·6335 | 16·8 | 56·8 | 940 | − 1·6 | 940 | − 1·6 | 1·114 | 857 | 22·2 |
| 51840.......... | 41 | 393 | 983 | 2·9926 | 1·6128 | 16·2 | 60·7 | 907 | − 7·7 | 907 | − 7·7 | 1·082 | 909 | 24·0 |
| 51852.......... | 40 | 371 | 928 | 2·9657 | 1·6021 | 15·9 | 58·4 | 891 | 4·0 | 891 | 4·0 | 1·067 | 870 | 23·2 |
| 51885.......... | 41 | 444 | 1,010 | 3·0043 | 1·6128 | 16·2 | 62·3 | 907 | − 9·2 | 907 | − 9·2 | 1·082 | 933 | 24·6 |
| 51904.......... | 42·5 | 408 | 1,020 | 3·0086 | 1·6284 | 16·6 | 61·5 | 932 | − 8·6 | 932 | − 3·2 | 1·114 | 916 | 24·0 |
| 51923.......... | 37 | 307 | 768 | 2·8854 | 1·5682 | 15·0 | 51·2 | 840 | 9·3 | 840 | 9·3 | 0·995 | 772 | 20·7 |
| 52010.......... | 40 | 261 | 653 | 2·8149 | 1·6021 | 15·9 | 41·1 | 891 | 36·4 | 891 | 34·6 | 1·067 | 612 | 16·3 |
| 52030.......... | 41 | 399 | 998 | 2·991 | 1·6128 | 16·2 | 61·6 | 907 | − 9·1 | 907 | − 9·1 | 1·082 | 922 | 24·3 |
| 52079.......... | 36 | 286 | 715 | 2·8543 | 1·5563 | 14·7 | 48·6 | 823 | 15·1 | 823 | 15·1 | 1·002 | 714 | 20·0 |
| 52082.......... | 42·5 | 341 | 853 | 2·9309 | 1·6281 | 16·6 | 51·4 | 932 | 9·2 | 932 | 9·2 | 1·114 | 766 | 20·0 |
| Average........ | 40 | 363 | 907 | — | — | — | 56 | — | 8·8 | — | 8·8 | — | 840 | 22·4 |
| Standard Deviation......... | — | — | — | — | — | — | — | — | — | — | — | — | 94 | 2·5 |
| Coef. Variation.. | — | — | — | — | — | — | — | — | — | — | — | — | 11 | 11 |

## TABLE 5.

### *Data on the Grass Consumption of Sheep under Natural Conditions of Grazing.*

FOURTH TEST: APRIL, 1939.

| Animal No. | Weight | Daily Dry Weight Faeces. | Daily Dry Weight of Grass Consumed, D.M. | Log DM. | Log W. | W ¾. | Dm. = KW ¾. K. | Dm. = 54 W ¾. | Percentage Deviation. | DM. = 56 W ¾. | Percentage Deviation. | Surface Area $S = \cdot 121\ W^{\cdot 59}$ | DM. per Square Metre. | DM. per Kilo-Gram. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Kgm. | Gram. | Gram. | | | | | Gram. | | Gram. | | Sq. M. | Gram. | Gram. |
| 51652.......... | 39 | 461 | 854 | 2·9309 | 1·5911 | 15·6 | 55·9 | 859 | + 0·6 | 874 | + 2·2 | 1·051 | 840 | 21·9 |
| 51689.......... | 33·6 | 347 | 643 | 2·8082 | 1·5263 | 13·9 | 46·0 | 767 | +19·2 | 781 | 21·4 | 0·962 | 668 | 19·1 |
| 51693.......... | 41 | 450 | 833 | 2·9206 | 1·6128 | 16·2 | 51·4 | 891 | + 6·9 | 907 | + 8·8 | 1·082 | 770 | 20·3 |
| 51694.......... | 47 | 484 | 896 | 2·9523 | 1·5682 | 15·0 | 59·7 | 825 | − 7·9 | 840 | − 6·2 | 1·019 | 879 | 24·2 |
| 51738.......... | 37 | 485 | 898 | 2·9533 | 1·5682 | 15·0 | 59·8 | 825 | − 8·1 | 840 | − 6·2 | 1·019 | 881 | 24·3 |
| 51741.......... | 38·2 | 443 | 820 | 2·9138 | 1·5821 | 15·4 | 53·4 | 845 | + 3·0 | 861 | + 5·0 | 1·038 | 790 | 21·5 |
| 51757.......... | 36 | 452 | 837 | 2·9227 | 1·5563 | 14·7 | 56·9 | 810 | − 3·2 | 823 | − 1·6 | 1·002 | 835 | 23·3 |
| 51761.......... | 39·5 | 522 | 967 | 2·9854 | 1·5966 | 15·8 | 61·4 | 867 | −10·3 | 882 | − 8·7 | 1·059 | 913 | 24·5 |
| 51765.......... | 34 | 454 | 841 | 2·9248 | 1·5315 | 14·1 | 59·7 | 775 | − 7·8 | 789 | + 6·1 | 0·969 | 868 | 24·7 |
| 51812.......... | 33 | 402 | 744 | 2·8716 | 1·5185 | 13·8 | 53·9 | 757 | + 1·7 | 771 | + 3·6 | 0·952 | 782 | 22·5 |
| 51833.......... | 41 | 497 | 920 | 2·9638 | 1·6128 | 16·2 | 56·7 | 891 | − 3·2 | 907 | − 1·4 | 1·082 | 850 | 22·4 |
| 51840.......... | 41 | 491 | 909 | 2·9586 | 1·6128 | 16·2 | 56·1 | 891 | − 1·0 | 907 | − 0·0 | 1·082 | 840 | 22·2 |
| 51852.......... | 41 | 506 | 937 | 2·9717 | 1·6128 | 16·2 | 57·8 | 891 | − 4·9 | 907 | − 3·2 | 1·082 | 866 | 22·9 |
| 51885.......... | 36 | 433 | 802 | 2·9042 | 1·5563 | 14·7 | 54·5 | 810 | + 1·0 | 823 | + 2·6 | 1·002 | 800 | 22·3 |
| 51923.......... | 37 | 431 | 798 | 2·9020 | 1·5682 | 15·0 | 53·2 | 825 | + 3·4 | 840 | + 5·2 | 1·019 | 783 | 21·6 |
| 52009.......... | 43 | 493 | 913 | 2·9605 | 1·6335 | 16·8 | 54·3 | 924 | + 1·2 | 940 | 2·9 | 1·114 | 820 | 21·2 |
| 52010.......... | 40 | 450 | 833 | 2·9206 | 1·6021 | 15·9 | 52·4 | 875 | + 5·0 | 891 | + 7·3 | 1·067 | 781 | 20·8 |
| 52030.......... | 40 | 453 | 839 | 2·9238 | 1·6021 | 15·9 | 52·7 | 875 | + 4·2 | 891 | + 6·9 | 1·067 | 786 | 21·0 |
| 52079.......... | 43 | 496 | 919 | 2·9633 | 1·6335 | 16·8 | 54·7 | 924 | + 0·5 | 940 | + 2·2 | 1·114 | 825 | 21·4 |
| 52082.......... | 46 | 549 | 1,017 | 3·0052 | 1·6628 | 17·7 | 57·4 | 972 | − 4·4 | 989 | − 2·8 | 1·158 | 878 | 22·1 |
| Average........ | 39 | 465 | 861 | — | — | — | 55 | — | 4·9 | — | 5·2 | — | 823 | 22·2 |
| Standard Deviation.......... | — | — | — | — | — | — | — | — | — | — | — | — | 55 | 1·5 |
| Coef. Variation.. | — | — | — | — | — | — | — | — | — | — | — | — | 7 | 7 |

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# The Utilization by Sheep of the Proteins contained in the Natural Grazing during Different Seasons of the Year.

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Onderstepoort.

In a previous paper we have shown that the dry matter consumption of sheep on natural grazing during different seasons of the year is very constant when expressed per ¾ power function of the weight. On this basis it was concluded that the phenomenon of weight reduction in sheep during the winter months is not due to a lowered dry matter consumption per unit of weight, but in all probability to the nutritional state of the winter pasture. In fact it seems fairly reasonable to assume that this depleted nutritional state of winter grazing may involve nutritional deficiencies of a complex nature, and that the magnitude of these deficiencies determines the extent of weight loss in animals. Existing evidence strongly suggests the latter point of view. It is by now well established that phosphorus is deficient in winter pasture. However, the addition of phosphorus alone does not remedy the condition of weight loss during winter. This condition alone affords confirmatory evidence of the possibility of additional nutritional deficiencies. Working on the hypothesis that other deficiencies apart from phosphorus exist in winter grazing, it was decided to investigate the possibility of an existing protein deficiency.

It is clear, however, that the question of a protein deficiency can only be settled by a systematic analysis of the entire problem. In other words, definite knowledge must be available on (1) the seasonal protein content of the pasture, (2) the quantity of pasture consumed daily, (3) the biological utilization of the protein in the pasture during different seasons of the year and (4) the maintenance protein requirements of the animals. It is only when these factors are known that a final and conclusive verdict on the question of a protein shortage can be given. An extensive survey on the chemical composition of the pastures in the Union of South Africa has been inaugurated in 1932 and now concluded (1939). This report includes a detailed monthly analysis of the protein content of pastures over the Union. Furthermore the dry matter consumption as well as the maintenance protein requirements of sheep have previously been determined by the authors (1938-39). In this study attention is therefore exclusively given to the third requirement namely the biological utilization of the proteins of the pasture during the different seasons of the year.

Very little work has apparently been done on the biological value of grazing. Thus far the majority of investigations dealing with the protein utilization of grasses or grazing consist almost exclusively of nitrogen balances, and can therefore not be compared with the biological values obtained in this study. Sotola (1930) has determined the biological value of alfalfa hay, corn silage and sunflower silage with sheep. The average values for the respective feeds were 56, 94 and 67. Turk, Morrison and Maynard (1934) found a much higher biological value for lucerne hay. Their values for lucerne hay and clover hay were 79 and 81 respectively. Smuts and Marais found an average value of 59 for lucerne hay with sheep. This value agrees exceptionally well with that of Sotola. The work of Morris, Wright and Fowler (1936) on cattle is probably more directly related to this study. They determined the biological values of the proteins contained in autumn and spring grass. Their values were 76·5 for the first type of grass and 63 for the latter. It is also evident from their work that there is no difference in the biological values of dry or green grass of the same season. Bartless and co-workers (1938) studied the effect of the different methods of drying on the biological values of grass proteins. They found that the highest biological value, namely 67, is associated with a drying temperature of 300° F. At a temperature of 170° F. the biological value drops to 62. It is also clear from the work of the above authors that the quality of the proteins of grass allowed to sun-dry is decidedly diminished since the biological value under these conditions drops to 52.

## EXPERIMENTAL.

Representative grazing cut during different seasons of the year, was utilized for these metabolism experiments. The grass was fed to five merino whethers under controlled experimental conditions. These sheep were first put on a nitrogen low diet, the composition of which was given previously, and then on a collection period of 10 days on the same ration. After this they were fed the grass for a preliminary period of 10 days, and then subjected to a collection period of the same duration. Grazing was fed without any form of supplementation except minerals to which sheep had free access under practical grazing conditions. It was realized that the present conditions of experimentation would not afford a true measure of the actual biological value of the protein contained in the respective seasonal grazings, since portion of the protein may be catabolized for energy purposes. However the main object in this investigation was to obtain a detailed picture of the biological utilization of the protein under the prevailing pastoral conditions.

## EXPERIMENTAL RESULTS.

In Table 1 are given the metabolism data on the natural grazing obtained during the different seasons of the year. The metabolic faecal nitrogen and the endogenous nitrogen values are representative of the nitrogen low period. These values represent the daily unavoidable nitrogen contribution of the body and do therefore not form an integral part of the undigested or unutilized portion of the grass protein.

## TABLE 1.

*Metabolism Data and Biological Values of Natural Grazing during Different Seasons of the Year.*

| Animal No. | Average Weight. | Grass Consumption. | Dry Matter Intake. | Nitrogen Intake. | Nitrogen in Faeces. | Metabolic Faecal Nitrogen. | Absorbed Nitrogen | Nitrogen in Urine. | Endogenous Nitrogen. | Food Nitrogen Retained. | Biological Value. | Nitrogen Balance. | Apparent Digestibility. | True Digestibility. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Grazing July, 1938 (0·49 per cent. N).* | | | | | | | | | | | | | | |
| | Kgm. | Grm. | Grm. | Grm. | Grm. | Grm. | Grm. | Grm. | Grm. | Grm. | | | Per cent. | Per cent. |
| 1.......... | 46 | 487 | 448 | 2·39 | 2·66 | 1·88 | 1·61 | 2·46 | 2·12 | 1·27 | 79 | —2·73 | 0·0 | 67 |
| 2.......... | 45 | 463 | 426 | 2·27 | 2·70 | 1·96 | 1·53 | 2·18 | 1·92 | 1·27 | 83 | —2·61 | 0·0 | 67 |
| 3.......... | 42 | 469 | 431 | 2·30 | 2·01 | 1·81 | 2·10 | 2·34 | 1·98 | 1·74 | 82 | —2·05 | 12·0 | 91 |
| 4.......... | 50 | 459 | 422 | 2·25 | 2·46 | 2·15 | 1·94 | 2·14 | 1·85 | 1·65 | 85 | —2·35 | 0·0 | 86 |
| 5.......... | 42 | 411 | 378 | 2·01 | 2·35 | 1·81 | 1·47 | 2·09 | 1·88 | 1·26 | 86 | 2·43 | 0·0 | 73 |
| | | | | | | | | | Average....... | | 83 | — | 2 | 77 |
| *Grazing October, 1938 (1·44 per cent. N).* | | | | | | | | | | | | | | |
| 38248.......... | 56 | 650 | 600 | 9·36 | 3·54 | 2·08 | 7·90 | 5·17 | 2·23 | 4·96 | 63 | 0·65 | 62 | 84 |
| 49612.......... | 53 | 769 | 723 | 11·07 | 4·83 | 2·89 | 9·13 | 6·06 | 2·52 | 5·59 | 61 | 0·18 | 56 | 82 |
| 38252.......... | 44 | 500 | 470 | 7·20 | 2·90 | 2·16 | 6·46 | 4·23 | 1·89 | 4·12 | 64 | 0·07 | 60 | 90 |
| 38243.......... | 48 | 640 | 602 | 9·22 | 3·73 | 2·40 | 7·89 | 4·79 | 1·73 | 4·83 | 61 | 0·70 | 60 | 86 |
| 39292.......... | 52 | 662 | 622 | 9·53 | 3·83 | 2·49 | 8·19 | 5·09 | 1·92 | 5·02 | 62 | 0·61 | 60 | 86 |
| | | | | | | | | | Average....... | | 62 | — | 60 | 85 |
| *Grazing January, 1939 (1·17 per cent. N).* | | | | | | | | | | | | | | |
| 38248.......... | 32 | 554 | 515 | 6·48 | 3·09 | 2·47 | 5·86 | 3·22 | 1·15 | 3·79 | 65 | 0·17 | 52 | 90 |
| 49612.......... | 52 | 809 | 752 | 9·47 | 4·81 | 3·53 | 8·19 | 4·27 | 2·29 | 6·21 | 76 | 1·39 | 49 | 86 |
| 38252.......... | 42 | 616 | 573 | 7·21 | 3·75 | 2·63 | 6·09 | 3·27 | 1·81 | 4·63 | 76 | 0·19 | 48 | 84 |
| 38240.......... | 44 | 744 | 692 | 8·70 | 4·09 | 2·90 | 7·51 | 3·74 | 2·02 | 5·79 | 77 | 0·87 | 53 | 86 |
| 39290.......... | 45 | 504 | 469 | 5·90 | 2·67 | 2·39 | 5·62 | 3·33 | 1·67 | 3·96 | 71 | 0·10 | 55 | 95 |
| | | | | | | | | | Average....... | | 74 | — | 51 | 88 |
| *Grazing April, 1939 (0·73 per cent. N).* | | | | | | | | | | | | | | |
| 38248.......... | 43 | 473 | 430 | 3·45 | 2·96 | 2·45 | 2·94 | 1·73 | 1·20 | 2·41 | 82 | —1·24 | 14 | 85 |
| 49612.......... | 46 | 500 | 455 | 3·65 | 3·24 | 2·96 | 3·37 | 2·18 | 1·52 | 2·71 | 80 | —1·77 | 11 | 92 |
| 38252.......... | 41 | 469 | 427 | 3·42 | 2·93 | 1·92 | 2·41 | 1·85 | 1·57 | 1·83 | 76 | —1·36 | 14 | 71 |
| 38240.......... | 41 | 499 | 454 | 3·64 | 3·15 | 2·59 | 3·08 | 1·73 | 1·64 | 2·99 | 97 | —1·24 | 13 | 85 |
| 38249.......... | 40 | 358 | 326 | 2·61 | 2·39 | 2·15 | 2·37 | 1·69 | 1·12 | 1·80 | 76 | —1·47 | 8 | 99 |
| | | | | | | | | | Average....... | | 82 | — | 12 | 86 |

During July, when the nitrogen content of the grazing is as low as 0·49 per cent., the total intake of this element is comparatively speaking also very low. The total intake of nitrogen for the five sheep varies from 2·39 to 2·01 grams per day. Except for sheep 3, the nitrogen excretion in the faeces is in every case greater than the nitrogen intake. Superficially these values would indicate that none of the grass protein is digested as illustrated under the apparent digestibility. However, if that portion of the faecal nitrogen, arising from the body is subtracted from the total faecal nitrogen, it will be seen that in reality 77 per cent. of the protein contained in the grazing during July is digested.

Schneider has shown that the metabolic faecal nitrogen consists of two portions, namely that which is proportional to the dry matter intake and a second portion which is dependent on the weight or in other words of endogenous nature. The second portion would, therefore, become more prominent under submaintenance conditions as is reflected in practice on grazing during the winter. Due to the relatively low intake of protein during the winter months, the metabolic faecal nitrogen becomes more prominent, and makes up a larger proportion of the total faecal nitrogen than during summer conditions, when the protein intake exceeds the maintenance requirements.

Sheep under winter conditions of grazing as represented by our July figures utilize the absorbed nitrogen with great efficiency as shown by the biological value of 83. This can be expected since these animals are definitely on a very low level of protein intake. The absorbed nitrogen is in most cases insufficient to supply the daily unavoidable losses of the body resulting from the endogenous protoplasmic activity. The result is that these sheep are continuously labouring under a complete negative nitrogen balance, as indicated in the Table.

When grazing conditions improve in the early summer with the coming of the first rains, the nitrogen content of the pasture responds immediately and attains an average value of 1·44 per cent., as shown by the October figures. Concomitant with this marked improvement in the protein content of the pasture there is also an equally marked change in the nitrogen metabolism of the sheep. The total nitrogen intake increases from approximately 2·3 grams in July to approximately 9·2 grams in October. The apparent digestibility during the month is 60 and the true digestibility 85. The absorbed nitrogen available for utilization is now about five times as great as during July conditions; and very decidedly above the maintenance requirement of the animals. Consequently the nitrogen is not utilized with such efficiency as during July, when the level of intake was very much lower and a protein shortage existed. The biological value obtained under October conditions is 60, which is not comparable to that of July, due to the difference in level of protein intake. However, it is clear that sheep during this season of the year is in a complete positive nitrogen balance. In fact it is doubtful if mature sheep could utilize a higher level of intake than that of October grazing to any greater advantage.

During January the nitrogen content of the pasture which has reached a more advanced state of growth has dropped to 1·17 per cent. This intake of nitrogen is, as will be seen from the metabolism data, adequate for the normal protein requirements of adult merino sheep. The protein contained in the grazing during this month is digested to the same extent as that of October. The average apparent digestibility is 51 and the true digestibility 88. Due to the slight decrease in protein content of the January pasture in comparison with that of October, there is naturally a more efficient utilization of the element during January. The average biological value is 74, compared with 62 during October.

In April, when the grazing has almost approached the winter state, its nitrogen content has dropped rapidly and averages 0·73 per cent. Nevertheless it is still slightly better than the July grazing, which represents grazing conditions during mid-winter. During April the total faecal nitrogen very nearly approaches that of the total nitrogen intake. The apparent digestibility of 12 per cent. is, however, still better than the 2 per cent. obtained under July conditions. It is evident that under April conditions of grazing, the protein intake has again dropped below maintenance level. Consequently efficient utilization is made of the meagre quantities of absorbed nitrogen, as is witnessed by the average biological value of 82 obtained for that period. As would be expected from the analysis of the metabolism data, sheep are definitely in a negative nitrogen balance.

## DISCUSSION.

A few points of practical and scientific interest arise from a consideration of the data. Firstly there appears to be a striking correlation between the nitrogen content of the pasture, the apparent digestibility and the biological value. In the former case the relationship appears to be direct or linear, while in the latter case the biological value appears to be inversely related to the protein content. Thus with a nitrogen content of 0·49 per cent., the apparent digestibility is 2 per cent. ond the biological value 83. With a nitrogen content of 0·79 per cent., the apparent digestibility is 12 per cent. and the biological value 82. In January the nitrogen content is 1·17, the apparent digestibility 51 and the biological value 74, while these figures in the above order is 1·44 per cent., 60 per cent. and 62 for October. From this relationship it appears possible to arrive at average figures for digestibility and biological value, if the protein content of the pasture is known.

Secondly it is interesting to note that during periods when the protein content of the grazing is low, the metabolic faecal nitrogen represents a greater proportion of the total faecal nitrogen than during periods of higher protein intake. It is believed that the endogenous portion of the metabolic faecal nitrogen, which is assumed to be constant per unit of weight, becomes more evident, as Schneider has shown under submaintenance conditions.

Thirdly, it is evident from the metabolism data, that although sheep utilize the protein of the grazing in April and July with great efficiency, the total intake of this element is nevertheless inadequate to supply the maintenance needs of mature sheep. From October to January, however, there is no shortage of protein in the pasture. In fact the grazing during these months supply ample protein for maintenance and growth. From a practical animal husbandry point of view it is, therefore, essential that the protein deficiency prevalent in the grazing from April to September be scientifically and economically rectified.

## SUMMARY AND CONCLUSIONS.

By means of controlled metabolism experiments it was shown that the biological value of the proteins in the natural grazing of the Transvaal varies according to the season of the year. During April the average biological value is 82, and during July the value obtained is 83. When the nitrogen content of the pasture increases, the biological value decreases. In October the average biological value is 62, and in January 74.

It has been shown by means of the above data that there is a protein deficiency in the pasture during the entire winter, starting in April and concluding round about August or September.

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# II.—The Carotene Content of Some South African Feeds.

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In a previous publication (1935), it was stated, that a Vitamin-A deficiency probably exists under ranching conditions during the dry periods of the year in South Africa. There are indications of such a deficiency due to the low carotene content of some mature veld grasses, which were analyzed. To test the existence of such a shortage, it was considered important that analyses of grass samples from the veld or under veld conditions, be carried out.

Since the preservation and conservation of grass hays for the feeding of animals in the dry periods in the summer-rainfall areas is not a general practice, the cattle on ranches have to seek their feed on the veld. Due, probably, to high temperatures in the summer and even in autumn, pasture grasses become mature very soon and the result is a rapid decline in the carotene content of even the best nutritional grasses.

Hart and Guilbert (1933) have found that, under ranching conditions in California, cattle suffer from a Vitamin-A deficiency during the dry spells. When the dry seasons were unusually prolonged the result was not only an actual shortage of carotene intake, but as a result poor growth, failure in reproduction, abortions, weak and sickly offspring amongst range cattle. Experimentally these facts were established by them in their classical work (1937) on cattle, swine and sheep, on low levels of Vitamin-A in rations. Minimum daily requirements were thus found and given as 25-30 micrograms carotene per Kilogram body weight. Excellent growth could still be obtained at these low levels of carotene (or Vitamin A), intake, but the storage over a long period was small.

An excellent study can thus be carried out in conjunction with a general survey of South African veld grasses, and valuable information so obtained, concerning the carotene content of our well-known grasses as an indication of a deficiency that may or may not exist.

The years 1932 and 1933 were exceedingly dry periods with no rain for months to bring about the onset of new growth of grass. During June, July, and August, 1932, there was no rain at all, and again May (June, 0·23 inches), July, August, September, and October, 1933, were dry months. Unluckily this work was begun only in 1935 and thus a very important period was missed. It is hoped that with the occurrence of such a period again, the necessary information will be obtained.

To obtain, as preliminary work, an indication of the carotene content of some important and indigenous grasses, the writer decided to cut from established experimental plots, monthly samples and analyse them. These grasses when once established, were left to grow under natural climatic conditions.

The plots referred to here are described in detail by J. G. Louw (1938) and the grasses selected for monthly cuttings over the period of a year were: *Chloris gayana*, *Digitaria eriantha* variety *Stolonifera*, *Cenchrus ciliaris*, *Eragrostis plana*, *Panicum maximum* and *Setaria lindenbergiana*.

Furthermore, a second series of analyses carried out on samples of grasses cut on experimental plots at Onderstepoort, at periods of one month, two months, three months and four months. The grasses in question were five in all, namely *Chloris gayana*, *Setaria lindenberginana*, *Cenchrus ciliaris*, *Digitaria pentzii* Pretoria Small, and *Panicum maximum*. The cutting of these grasses was really intended to obtain information on " The Influence of Frequency of Cutting on the Yield of Dry Matter " (see J. G. Louw, 1938).

These grasses, therefore, represent various growth stages up to four months for the season January to April (inclusive), 1936. Lastly, air dried samples of grasses, cut on the veld at monthly intervals and sent in from the experimental farms Armoedsvlakte, Vryburg (Bechuanaland) and Nooitgedacht, (highveld, Transvaal) were analysed. These samples were cut for analysis during the period August, 1935, to August, 1936, and analysed shortly after cutting. It is hoped to publish values for the carotene content of veldgrass samples for these areas for further periods up to date in the near future.

## EXPERIMENTAL.

Samples for analyses were cut from selected experimental plots and a central position was chosen for cutting. Care was taken, that samples were not cut at the same spots where previous monthly cuttings had been made. In other words, a new position on each plot was selected for each monthly cutting. Thus the effect of cutting on the carotene content was eliminated. The fresh grass was immediately bottled in closed jars and analysed soon afterwards in the laboratory. Moisture determinations were made on the fresh grass by weighing in closed jars, before and after drying at 103° C. Fresh green grasses could be analysed without milling or any pretreatment, except that of cutting into small bits. Old, dry and mature grasses were firstly milled and sampled for analyses. All values for carotene are given in the tables, as well as moisture values where necessary, and meteorological data for the periods concerned.

## METHOD AND TECHNIQUE OF ANALYSES FOR CAROTENE.

The method employed is the same as that previously adopted by the author (1935) and advocated by Guilbert (1934), except for a minor modification. After the extraction and saponification of the fat soluble pigments with alcoholic potash, the writer re-extracted the alcoholic extracts with petroleum ether instead of with ethyl-ether. This simplified the procedure considerably.

The standard for colorimetric comparison was the Dye-Standard of Guilbert, where 1 litre of the dye solution represented 2·4 mg. carotene.

## DISCUSSION.

As previously indicated by the writer (1935), there is a decrease in carotene for pasture grass samples in the veld or for established grasses on plots during the dry months (winter) and this is especially marked in late winter. This fact can be clearly seen by studying Table VII and Table VIII, where values are given for veld grasses from the experimental farms at Vryburg and Ermelo. Rather dry winters were experienced during the years 1935 and 1936 as can be gathered from Table IX.

Calculating the average daily intake of carotene for cattle on the basis given by Guilbert (1937), namely 25 micrograms per Kilogram body weight and furthermore, assuming that an 800 lbs. bovine consumed on an average 15 lbs. dry weight of hay daily, we find that a deficiency of carotene existed for the dry months of June, July, August, and September, (1935 and 1936). This deficiency is based on the formula of Guilbert according to which the animal requires 9 milligram carotene per day to prevent the onset of clinical symptoms. Substantially more carotene would be necessary to build up a reserve and this the animal is able to do during the summer months. On the other hand depletion of carotene takes place very rapidly. Guilbert (1935) gives the daily withdrawals from storage as from 9 to 11 micrograms per Kilogram body weight. In comparison with 1935 and 1936 on the other hand, the years 1938 and 1939 were good years with substantial falls of rain even as late as May and July, 1939. Accordingly, the values for the season August, 1938, to August, 1939, for which reference should be made to Table I or I (*a*), were exceptionally high, and taken on an average there existed no deficiency for the six grasses analysed. Some of the individual grasses did show a markedly serious fall in carotene verging on the critical value to prevent clinical symptoms, in the late winter of 1938. This was largely due to a fairly dry spell from May until September when only small average rainfalls took place. Some types of grasses, as for instance *Chloris gayana* will sprout in winter even with little rain whereas *Panicum maximum* rarely does, and thus new growth is accompanied by an increase in Carotene. It is anticipated that, during the seasons when the rainfall is low and the hot weather hastens the maturing of the veld grasses, a prolonged dry spell starting with winter would result in a likely shortage of Vitamin A, if not in a serious deficiency in the summer-rainfall areas.

## TABLE I.

*Carotene Content of Grasses cut monthly from Experimental Plots (Onderstepoort).*

*Expressed as mg. per cent. on Natural Basis.*

| Type of Grass. | Period. | Aug. 1938. | Sept. | Oct. | Nov. | Dec. | Jan. 1939. | Feb. | March. | April. | May. | June. | July. | Aug. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. ***Chloris gayana*** (" Rhodes Grass ") | Carotene | 0·44 | 2·62 | 2·47 | 4·00 | 4·34 | — | 2·55 | 3·84 | 3·36 | 1·16 | 1·74 | 0·53 | 0·64 |
| | Moisture | 15·00 | 30·00 | 33·30 | 68·50 | 71·60 | — | 66·00 | 68·30 | 68·60 | 66·60 | 55·50 | 27·70 | 11·60 |
| 2. ***Digitaria eriantha*** var. ***Stolonifera*** | Carotene | 0·12 | 1·31 | 4·24 | 5·82 | 10·90 | — | 3·95 | 2·80 | 2·77 | 0·79 | 0·48 | 0·33 | 0·27 |
| | Moisture | 8·30 | 23·80 | 32·00 | 63·50 | 72·20 | — | 65·40 | 68·70 | 55·50 | 30·00 | 16·60 | 18·10 | 7·70 |
| 3. ***Cenchrus ciliaris*** (" Buffelsgras ") | Carotene | 0·05 | 0·13 | 4·29 | 5·33 | 7·35 | — | 2·74 | 4·57 | 1·28 | 0·14 | 0·59 | 0·21 | 0·15 |
| | Moisture | 21·40 | 38·00 | 43·10 | 73·80 | 82·20 | — | 56·30 | 72·50 | 69·80 | 30·70 | 21·40 | 24·30 | 8·30 |
| 4. ***Eragrostis plana*** .......... | Carotene | 0·05 | 0·20 | 0·20 | 0·80 | 8·06 | — | 5·57 | 7·74 | 3·15 | 0·10 | 0·37 | 0·15 | 0·24 |
| | Moisture | 5·00 | 14·20 | 14·00 | 30·50 | 45·10 | — | 41·80 | 70·30 | 54·50 | 20·00 | 20·00 | 17·00 | 13·80 |
| 5. ***Panicum maximum*** (Hairy " Buffelsgras ") | Carotene | 0·09 | 0·21 | 1·13 | 2·00 | 7·70 | — | 1·73 | 2·62 | 2·77 | 0·18 | 0·14 | 0·04 | 0·06 |
| | Moisture | 14·80 | 26·00 | 12·30 | 48·80 | 75·00 | — | 71·10 | 72·50 | 54·70 | 31·70 | 30·00 | 25·00 | 7·40 |
| 6. ***Setaria lindenbergiana*** ..... | Carotene | 0·47 | 0·40 | 1·93 | 2·91 | 9·41 | — | 4·57 | 3·60 | 3·20 | 0·34 | 0·33 | 0·16 | 0·24 |
| | Moisture | 15·20 | 31·10 | 9·50 | 16·00 | 72·10 | — | 60·20 | 60·00 | 50·00 | 34·50 | 18·10 | 26·50 | 6·10 |

## TABLE I (a).

*Carotene Content of Grasses cut monthly from Experimental Plots (Onderstepoort).*

*Expressed as mg. percentage on dry basis.*

| Type of Grass. | Period. | Aug. 1938. | Sept. | Oct. | Nov. | Dec. | Jan. 1939. | Feb. | March. | April. | May. | June. | July. | Aug. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. ***Chloris gayana*** ("Rhodes Grass") | — | 0·52 | 3·75 | 3·70 | 12·70 | 15·30 | — | 7·50 | 12·10 | 10·70 | 3·47 | 3·91 | 0·73 | 0·71 |
| 2. ***Digitaria eriantha*** var. ***Stolonifera*** | — | 0·13 | 1·72 | 6·23 | 16·00 | 39·20 | — | 11·40 | 8·94 | 6·23 | 1·13 | 0·58 | 0·40 | 0·29 |
| 3. ***Cenchrus ciliaris*** ("Buffelsgras") | — | 0·06 | 0·21 | 7·54 | 20·30 | 41·30 | — | 6·26 | 16·60 | 4·23 | 0·20 | 0·75 | 0·28 | 0·16 |
| 4. ***Eragrostis plana*** | — | 0·05 | 0·23 | 0·23 | 1·15 | 14·70 | — | 9·56 | 26·10 | 6·92 | 0·12 | 0·46 | 0·18 | 0·28 |
| 5. ***Panicum maximum*** (Hairy "Buffelsgras") | — | 0·11 | 0·28 | 1·29 | 3·91 | 30·85 | — | 5·98 | 9·52 | 6·10 | 0·23 | 0·20 | 0·05 | 0·06 |
| 6. ***Setaria lindenbergiana*** | — | 0·55 | 0·58 | 2·13 | 3·46 | 33·70 | — | 11·50 | 9·00 | 6·40 | 0·52 | 0·40 | 0·22 | 0·25 |

## TABLE II.

*Daily Intake of Carotene (mg.) for Cattle (800 lb. Live-weight) calculated from Table I (a).*

| Type of Grass. | Aug. 1938. | Sept. | Oct. | Nov. | Dec. | Jan. 1939. | Feb. | March. | April. | May. | June. | July. | Aug. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. ***Chloris gayana*** ("Rhodes Grass") | 35 | 253 | 250 | 857 | 1,032 | — | 506 | 818 | 723 | 234 | 264 | 49 | 49 |
| 2. ***Digitaria eriantha*** var. ***Stolonifera*** | 9 | 116 | 420 | 1,080 | 2,664 | — | 769 | 603 | 420 | 76 | 39 | 27 | 20 |
| 3. *Cenchus ciliaris* ("Buffelsgras") | 4 | 14 | 508 | 1,370 | 2,790 | — | 423 | 1,120 | 285 | 14 | 51 | 19 | 11 |
| 4. ***Eragrostis plana*** | 3 | 16 | 15 | 78 | 990 | — | 645 | 1,760 | 467 | 8 | 31 | 12 | 19 |
| 5. ***Panicum maximum*** (Hairy "Buffelsgras") | 7 | 19 | 87 | 264 | 2,080 | — | 403 | 642 | 414 | 15 | 13 | 4 | 4 |
| 6. ***Setaria lindenbergiana*** | 37 | 39 | 144 | 233 | 2,275 | — | 775 | 607 | 433 | 35 | 27 | 15 | 17 |
| Average for 6 Grasses | 16 | 76 | 237 | 647 | 1,972 | — | 587 | 925 | 457 | 64 | 71 | 21 | 20 |
| Minimum Daily Requirement according to Guilbert | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |

## TABLE III.

*Meteorological Data—Onderstepoort, Transvaal.*

| Date. | Average Rainfall. | Average Maximum Temperature. | Average Minimum Temperature. | Difference between Maximum and Minimum Temperature. |
|---|---|---|---|---|
| 1938. | (Inches). | °F. | °F. | °F. |
| January | 5·52 | 82·2 | 59·7 | 22·5 |
| February | 2·56 | 79·4 | 58·8 | 20·6 |
| March | 1·24 | 86·9 | 52·2 | 34·7 |
| April | 2·94 | 83·8 | 48·0 | 35·8 |
| May | 0·30 | 77·0 | 38·6 | 38·4 |
| June | 0·19 | 68·1 | 35·6 | 32·5 |
| July | 0 | 60·5 | 34·3 | 26·2 |
| August | 0·24 | 66·6 | 36·6 | 30·0 |
| September | 0·33 | 74·9 | 39·8 | 35·1 |
| October | 2·81 | 82·5 | 55·4 | 27·1 |
| November | 1·23 | 86·7 | 52·6 | 34·1 |
| December | 10·70 | 84·4 | 54·5 | 29·9 |
| 1939. | | | | |
| January | 5·24 | 84·8 | 57·4 | 27·4 |
| February | 8·82 | 84·0 | 58·2 | 25·8 |
| March | 2·75 | 75·7 | 48·6 | 27·1 |
| April | 0·07 | 74·2 | 44·2 | 30·0 |
| May | 2·54 | 74·0 | 39·9 | 34·1 |
| June | 0 | 68·5 | 32·8 | 35·7 |
| July | 2·44 | 65·4 | 33·8 | 31·6 |
| August | 0·40 | 70·2 | 37·5 | 32·7 |

## TABLE IV.

*Carotene Content of Plot Grasses cut from Experimental Plots, Onderstepoort, expressed as mg. Per cent Carotene on Dry Basis.*

| Date of Analysis. 1937. | *Chloris gayana.* | *Setaria lindenbergiana.* | *Cenchrus ciliaris.* | *Digitaria pentzii* Pretoria Small. | *Panicum maximum.* |
|---|---|---|---|---|---|
| 1-Monthly Cuttings 6/1/36; 4/2/36; 3/3/36; 5/4/36 (pooled). | 2·36 | 3·00 | 2·40 | 1·86 | 2·12 |
| 2-Monthly Cuttings 4/2/36; 6/4/36 (pooled) | 2·00 | 1·71 | 1·80 | 1·50 | 1·89 |
| 3-Monthly Cuttings 3/3/36... | 0·90 | 1·74 | 1·74 | 1·20 | 1·71 |
| 4-Monthly Cuttings 6/4/36... | 0·85 | 1·62 | 1·33 | 1·30 | 1·20 |

## TABLE V.

*Daily Intake of Carotene (mg.) for Cattle (800 lb. Live-weight) calculated from Table IV.*

| | *Chloris gayana.* | *Setaria lindenbergiana.* | *Cenchrus ciliaris* | *Digitaria pentzii* Pretoria Small. | *Panicum maximum.* |
|---|---|---|---|---|---|
| 1-Monthly Cuttings.......... | 159 | 202 | 162 | 126 | 143 |
| 2 Monthly Cuttings...... .. | 135 | 115 | 121 | 101 | 128 |
| 3-Monthly Cuttings.......... | 61 | 117 | 117 | 81 | 115 |
| 4-Monthly Cuttings....... . | 57 | 109 | 90 | 87 | 81 |
| Average Minimum Requirement | 9 | 9 | 9 | 9 | 9 |

## TABLE VI.

*Meteorological Data—Onderstepoort.*

| Date. | Average Rainfall. | Average Maximum Temperature. | Average Minimum Temperature. | Difference between Maximum and Minimum Temperature. |
|---|---|---|---|---|
| 1935. | (Inches). | F. | F. | F. |
| September...................... | 0·36 | 81·8 | 43·9 | 37·9 |
| October......................... | 0·97 | 91·1 | 52·2 | 38·9 |
| November...................... | 2·09 | 88·2 | 55·5 | 32·7 |
| December...................... | 3·17 | 87·6 | 56·8 | 30·8 |
| 1936. | | | | |
| January........................ | 4·69 | 87·6 | 58·1 | 29·5 |
| February...................... | 7·67 | 85·2 | 58·3 | 26·9 |
| March.......................... | 8·50 | 80·0 | 56·1 | 23·9 |
| April............................ | 0·51 | 79·8 | 49·0 | 30·8 |
| May............................. | 4·26 | 71·4 | 40·6 | 30·8 |
| June............................ | 0 | 72·1 | 33·4 | 38·7 |
| July............................. | 0 | 70·7 | 33·6 | 37·1 |
| August......................... | 0 | 76·0 | 36·2 | 39·8 |
| September.................... | 0·46 | 77·6 | 40·6 | 37·0 |
| October........................ | 2·69 | 83·2 | 51·4 | 31·8 |
| November..................... | 0·54 | 82·2 | 54·5 | 27·7 |
| December...................... | 3·37 | 88·0 | 55·5 | 32·5 |

### TABLE VII.

A.—*Carotene Content of Veld Grass—Armoedsvlakte, Vryburg, expressed as mg. per cent. Carotene on Dry Basis.*

| | Aug. 1935. | Sept. | Oct. | Nov. | Dec. | Jan. 1936. | Feb. | March. | April. | May. | June. | July. | Aug. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ·06 | ·10 | ·28 | ·28 | ·55 | 1·08 | 0·71 | 0·83 | 1·15 | 0·70 | 0·08 | 0·11 | 0·12 |

B.—*Daily Intake of Carotene (mg.) for Cattle (800 lb. Live-weight) calculated from Table* VII.

| | Aug. 1935. | Sept. | Oct. | Nov. | Dec. | Jan. 1936. | Feb. | March. | April. | May. | June. | July. | Aug. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4 | 7 | 19 | 19 | 37 | 73 | 48 | 56 | 77 | 77 | 5 | 7 | 8 |
| Average minimum requirement................. | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |

### TABLE VIII.

A.—*Carotene Content of Veld Grass—Experimental Farm, Ermelo, expressed as mg. per cent. Carotene on Dry Basis.*

| | Aug. 1935. | Sept. | Oct. | Nov. | Dec. | Jan. 1936. | Feb. | March. | April. | May. | June. | July. | Aug. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0·18 | 0·08 | 0·13 | 0·36 | 1·34 | 1·00 | 1·07 | 1·50 | 1·07 | 0·60 | 0·13 | 0·05 | 0·08 |

B.—*Daily Intake of Carotene (mg.) for Cattle (800 lb. Live-weight) calculated from Table* VIII.

| | Aug. 1935. | Sept. | Oct. | Nov. | Dec. | Jan. 1936. | Feb. | March. | April. | May. | June. | July. | Aug. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12 | 5 | 9 | 24 | 90 | 67 | 72 | 101 | 72 | 40 | 9 | 3 | 5 |
| Average Minimum Requirements................. | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |

## TABLE IX.

*Meteorological Data—Armoedsvlakte, Vryburg, Bechuanaland.*

| Date. | Average. Rainfall. | Average Maximum Temperature. | Average Minimum Temperature. | Difference between Maximum and Minimum Temperature. |
|---|---|---|---|---|
| 1935. | (Inches). | F. | F. | F. |
| January | 0·93 | 92·74 | 56·15 | 36·59 |
| February | 2·69 | 86·84 | 56·99 | 29·85 |
| March | 2·66 | 80·47 | 53·54 | 26·93 |
| April | 1·94 | 75·49 | 46·51 | 28·98 |
| May | 0·60 | 69·31 | 37·37 | 31·94 |
| June | 0 | 64·93 | 29·20 | 35·73 |
| July | 0 | 70·20 | 31·20 | 39·00 |
| August | 0 | 68·76 | 31·09 | 37·67 |
| September | 0·25 | 77·82 | 39·98 | 37·84 |
| October | 0·52 | 90·48 | 53·76 | 36·72 |
| November | 1·15 | 86·76 | 54·98 | 31·78 |
| December | 3·98 | 88·43 | 59·89 | 28·54 |
| 1936. | | | | |
| January | 2·51 | 87·74 | 57·36 | 30·28 |
| February | 3·61 | 85·94 | 58·02 | 29·96 |
| March | 3·23 | 78·98 | 56·08 | 22·90 |
| April | 0·06 | 79·96 | 46·61 | 33·35 |
| May | 1·11 | 68·27 | 39·82 | 28·45 |
| June | 0·02 | 69·13 | 32·65 | 26·48 |
| July | 0 | 67·84 | 33·15 | 34·72 |
| August | 0 | 74·50 | 34·70 | 39·80 |

## SUMMARY.

1. Carotene values are given for six well-known grasses, cut monthly from established plots under natural climatic conditions at Onderstepoort from August, 1938, to August, 1939.

2. If the average bovine (800 lb. body weight) requires 9 milligrams carotene per day, then there exists no actual Vitamin-A deficiency for the season in question.

3. Carotene values are given for grasses cut at one-monthly up to four-monthly periods during the growth stage.

4. The average intakes of carotene from these grasses are well above the minimum requirements of stock.

5. Carotene values are given for veld grasses cut on the veld from the areas Vryburg, Bechuanaland and Ermelo on the Highveld of the Transvaal during the years 1935 and 1936, and analysed shortly afterwards.

6. Here for the period in question, there is a strong indication of a likely Vitamin A deficiency during the dry months.

## ACKNOWLEDGEMENTS.

The writer appreciates useful advice readily given by Dr. A. I. Malan.

## ERRORS IN PUBLICATION, 1935.

(*a*) 50 c.c. of the stock solution to 1,000 c.c. etc., should read 5·0 c.c. of the stock solution to 1,000 c.c., etc. See page 479.

(*b*) Value of Dye Standard used = 2·7 per 1,000 c.c. carotene and not per cent., as given in Tables A and B. See page 479.

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# Section VI.

# Toxicology
AND
# Poisonous Plants.

DE WAAL, H. L. ... ... The Senecio Alkaloids. Part 2. Hydrogenation, hydrolysis and structural results of isatidine ... ... ... ... ... ... 433

*Onderstepoort Journal of Veterinary Science and Animal Industry, Volume 14, Numbers 1 and 2, January and April, 1940.*

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# The Senecio Alkaloids. Part 2: Hydrogenation, Hydrolysis and Structural Results of Isatidine.

By H. L. DE WAAL, Section of Pharmacology and Toxicology, Onderstepoort.

In the first paper of this series (de Waal, 1939) the isolation and chemical properties as well as the results of the preliminary hydrolysis and of the hydrogenation of the alkaloid isatidine were recorded. This alkaloid is the active principle particularly of *Senecio isatideus* but was also found to be present in very much smaller quantities in *S. retrorsus* D.C. It was then found that when isatidine was hydrogenated in the presence of platinum dioxide four molecules of hydrogen were consumed, which at the time could not be explained. Continuous efforts have since led to the repeated and facilitated isolation of the reduced compound in the crystalline form, and this as well as some other structural results on isatidine are now reported upon.

## *The Nature of the Hydrogenated Substance.*

The hydrogenation of isatidine ($PtO_2$) in half-normal or normal-hydrochloric acid solution leads to the consumption of four molecules of hydrogen for one molecule of the alkaloid. The resulting hydrogenated product has been isolated both as the free base and as its hydrochloride. Both are laevo-rotatory, crystalline substances and the analysis revealed a striking phenomenon. Isatidine, $C_{18}H_{25}NO_7$ took up 4 molecules of hydrogen, then split off one molecule of water, so that the resulting base has the formula $C_{18}H_{31}O_6N$ or $C_{18}H_{31}O_6N.HCl$ for its hydrochloride, thus:

$$C_{18}H_{25}NO_7 + 4H_2 = [C_{18}H_{33}NO_7]$$
$$[C_{18}H_{33}NO_7] - H_2O = C_{18}H_{31}NO_6.$$

Octahydro-anhydro-isatidine.

## *Hydrolysis of Octahydro-anhydro-isatidine.*

When octahydro-anhydro-isatidine was hydrolysed with barium-hydroxide, the split in the molecule occurred at the same place as is the case with isatidine, i.e. a basic fission product containing 8 carbon atoms was produced, viz. $C_8H_{17}O_3N$, a tetrahydro-derivative of isatinecine ($C_8H_{13}O_3N$). Barger and his associates (1932) hydrogenated retrorsine (as its diacetyl derivative) and found that only two molecules of hydrogen were used. They failed to isolate the hydrogenated substance but isolated from the hydrolysis mixture a base $C_8H_{15}ON$ (retronecine has the formula $C_8H_{13}O_2N$), which they named retronecanol. Our base, $C_8H_{17}O_3N$, contributes new information towards the chemistry of the Senecio alkaloids, a hydrogenated base having been obtained without any loss of oxygen atoms. The hydrogen has therefore saturated most likely ethylenic or benzylenic double bonds only and the possibility of an enolic-CO-$CH_2$-grouping as suggested for retrorsine must be ruled out for isatidine.

## *The Function of the Oxygen Atoms in Isatinecine, Isatinecic Acid and Isatidine.*

It must be accepted meanwhile that isatinecine $C_8H_{13}O_3N$, has three reactive hydrogen atoms although this could not be acetylated or determined (Zerewitinoff), in the latter case due to its insolubility in either pyridine or anisole.

Isatinecic acid $C_{10}H_{16}O_6$, is a dihydroxy, dicarboxylic acid and the function of all its six oxygen atoms is therefore known.

Isatidine, $C_{18}H_{25}NO_7$, according to Blackie (1937) may have three reactive hydrogen atoms (i.e. hydroxyl-groups), and the remaining four oxygen atoms must then be contained either in two ester-linkages or in one ester-linkage and one lactone group.

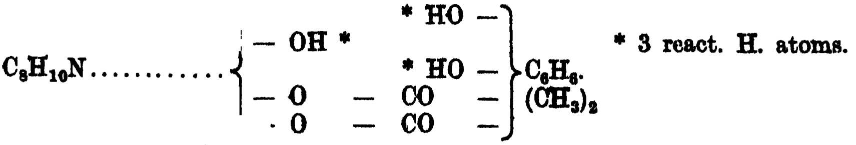
Isatinecic acid so readily forms a monolactone (see experimental part), that the slightest deviation from the optimum conditions for the formation of the dibasic acid results in the isolation of the monobasic monolactonic acid. The equation for the hydrolysis of the alkaloid may therefore be either:

$$\text{I. } \underset{\text{isatidine}}{C_{18}H_{25}NO_7} + 2\ H_2O = \underset{\text{isatinecine}}{C_8H_{13}O_3N} + \underset{\text{isatinecic acid or the 'new' acid (see p. 445).}}{C_{10}H_{16}O_6}$$

or

$$\text{II. } \underset{\text{isatidine}}{C_{18}H_{25}NO_7} + H_2O = \underset{\text{isatinecine}}{C_8H_{13}O_3N} + \underset{\text{isatinecic monolactone.}}{C_{10}H_{14}O_5}$$

Reversely the alkaloid can therefore either be constituted by the combination of the dibasic acid, $C_{10}H_{16}O_6$, with the base isatinecine, $C_8H_{13}O_3N$, by two ester-linkages, e.g.

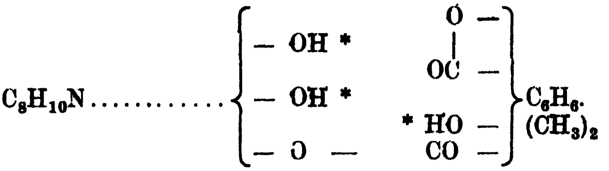


$$C_8H_{10}N\ldots\ldots\ldots\ldots\left\{\begin{array}{lcl} & & {}^*\,HO\ - \\ -\ OH\ {}^* & & \\ & & {}^*\,HO\ - \\ -\ O & - & CO\ - \\ \cdot\ O & - & CO\ - \end{array}\right\}\begin{array}{l} C_6H_6\cdot \\ (CH_3)_2 \end{array}$$

* 3 react. H. atoms.

$C_{18}H_{25}NO_7$ (isatidine)—see equation I.

Or the alkaloid may be a combination by one ester-linking of isatinecine with the monolactonic acid as follows:—



$$C_8H_{10}N\ldots\ldots\ldots\ldots\left\{\begin{array}{ll} & O- \\ -OH^* & | \\ & OC- \\ -OH^* & \\ & {}^*HO- \\ -O- & CO- \end{array}\right]\begin{array}{l}C_6H_6.\\(CH_3)_2\end{array}$$

* 3 react. H. atoms.

$C_{18}H_{15}NO_7$ (isatidine)—see equation II.

*The Nature of the Natural and Hydrogenated Isatinecic Acids.*

As is described in the experimental part isatidine yields two different acids on hydrolysis, depending upon the method used. With alcoholic KOH a dibasic acid, $C_{10}H_{16}O_6$, with melting-point 181·5° C.* and dextro-rotatory is obtained (see de Waal, 1939); this acid as has now been found also forms monobasic monolactonic acid. Using $Ba(OH)_2$ for the hydrolysis an isomeric dihydroxy-dibasic acid is obtained, with melting-point 148·5° C. and either inactive or dextro-rotatory. Its corresponding monolactone has now also been isolated for the first time with an $[\alpha]^{20}_{D} = +108{\cdot}8(H_2O)$ and a melting-point of 197-8°C. In a private communication to the author, Dr. J. J. Blackie of Edinburgh suggested the name " isatinecic acid " to the $Ba(OH)_2$ hydrolysis acid of m.p. 148·5° C. which we now will retain in future, and the KOH-hydrolysis acid of melting-point 181·5° C. will meanwhile be termed the " new " acid until its identification has been completed and a suitable name, if necessary, suggested.

Both " isatinecic " acid and the " new " acid as well as their monolactones (which incidentally prove that in each case one hydroxyl-group must be situated in the γ-position to one carboxyl-group) can be very readily hydrogenated in the presence of $PtO_2$. In each case 2 molecules of hydrogen are consumed for one molecule of the acid. As these hydrogenated acids persist to be of a syrupy nature it is hoped that it will be possible to isolate ester-derivatives in a crystalline form.

Now octahydro-anhydro-isatidine, $C_{18}H_{31}O_6N$, on hydrolysis yields a basic fraction $C_8H_{17}O_3N$, thus accounting for two molecules or four atoms of hydrogen. Again, octahydro-anhydro-isatidine shows a nett increase of six hydrogen atoms only and a loss of one oxygen atom (although 8 atoms of hydrogen had been taken up during the hydrogenation). Therefore the loss of two hydrogen atoms and one oxygen atom *as one molecule of water must have occurred in the acidic moiety* of the hydrogenated substance, $C_{18}H_{31}O_6N$. If such an intramolecular elimination of one molecule of water had taken place in the acidic fraction of the molecule, then it is expected that the hydrolysis of octahydro-anhydro-isatidine will lead to the isolation of a $C_{10}H_{20}O_6$ dibasic acid which had lost one molecule of water, i.e. a $C_{10}H_{18}O_5$ dibasic acid. Should the hydrolysis lead to the isolation of a monolactonic acid, then similarly its formula will be $C_{10}H_{16}O_4$ (i.e. $C_{10}H_{18}O_5 - H_2O$).

---

* All melting-points are corrected (Kofler micro-melting-point apparatus).

It is also perfectly clear from the two part formulae for isatidine (see page 434) that the loss of one molecule of water in the acidific moiety of the hydogenated substance cannot be due to a lactone formation in that part of the molecule. It can only be accounted for by the reaction of one hydroxyl-group with one other hydrogen atom to eliminate one molecule of water in the acidic fraction of the molecule.

It is hoped that this obscure problem will be clarified in our next contribution on the subject after the number of the reactive H atoms in octahydro-anhydro-isatidine has been determined and the hydrogenated acidic fraction has been isolated. Similarly it will be interesting to know whether the same phenomenon of water elimination takes place during the hydrogenation of isatinecic acid itself as well as its monolactone.

## EXPERIMENTAL PART.

### *Catalytic Hydrogenation and Reduction of Isatidine and the Isolation of Octahydro-anhydro-isatidine.*

10 Gms. Isatidine dissolved in 70 c.c. N hydrochloric acid was hydrogenated under continuous mechanical shaking (Gattermann and Wieland, 1936) using 200 mgm. platinum-dioxide as catalyst. The hydrogen consumption advanced as follows:—

The first molecule of hydrogen was taken up after 100 minutes, i.e. at the rate of 420 c.c. $H_2$ per hour.

The second molecule of hydrogen was taken up after a further 110 minutes, i.e. 390 c.c. $H_2$ per hour.

The third molecule of hydrogen was taken up after a further 145 minutes, i.e. at about 290 c.c. $H_2$ per hour.

The fourth molecule of hydrogen was taken up after approximately 250 minutes, i.e. at about 170 c.c. per hour.

Various independent hydrogenations with 3 gms., 12 gms. and 20 gms. of isatidine and 100 mgm., 200 mgm. and 500 mgm. platinum-dioxide respectively in water, half-normal and normal hydrochloric acid solutions all proved that the first two molecules of hydrogenation were absorbed at practically the same rate but that the consumption of the third molecule of hydrogen was much slower, whereas the fourth molecule of hydrogen was consumed at a still more reduced rate.

The hydrogenated acid solution (above) of 10 gms. of isatidine was very unstable towards acid or soda-alkaline permanganate solutions and gave strong precipitates with Mayer's, Wagner's and Dragendorf's reagents and with phospho-tungstic acid. Thorough shakings of this acid solution with ether or with chloroform removed nothing. The solution was then alkalinified with concentrated ammonium hydroxide (1 : $3H_2O$), allowed to evaporate and finally dried in a vacuous desiccator over concentrated sulphuric acid. The residue was then extracted first with acetone (twice) and then with chloroform followed by absolute alcohol.

The acetone solution deposited a good crop of crystals (about 2 gms.) and the chloroform solution on evaporation left about 5 gms. of an oily substance.

The purified crystals (see Fig. 1) from the acetone solution was dissolved in a little absolute alcohol from which it crystallized in clusters of needles on the addition of a small volume of dry ether. From the oily residue of the chloroform extract the same substance was isolated after repeated treatment of the oil with acetone. The acetone washings deposited the same base as was isolated above. This base exhibited a double melting point. It melted at 115 to 120°, resolidified and finally melted to a clear solution at 183 to 184° C.

FIG. 1.

Octa-hydro-anhydro-isatidine x 35.

*Micro-analysis.*

5·347 mgm.: 11·565 mgm. $CO_2$; 4·170 mgm. $H_2O$.

3·144 mgm.: 0·104 c.c. N at 22·5° C. and 766 m.m.

Calculated for $C_{18}H_{31}O_6N$:

$C=60{\cdot}48$ per cent.; $H=8{\cdot}74$ per cent.; $N=3{\cdot}92$ per cent.

found:

$C=59{\cdot}01$ per cent.; $H=8{\cdot}73$ per cent.; $N=3{\cdot}85$ per cent.

(See confirmation of this formula from the analysis of its hydrochloride, p. 439).

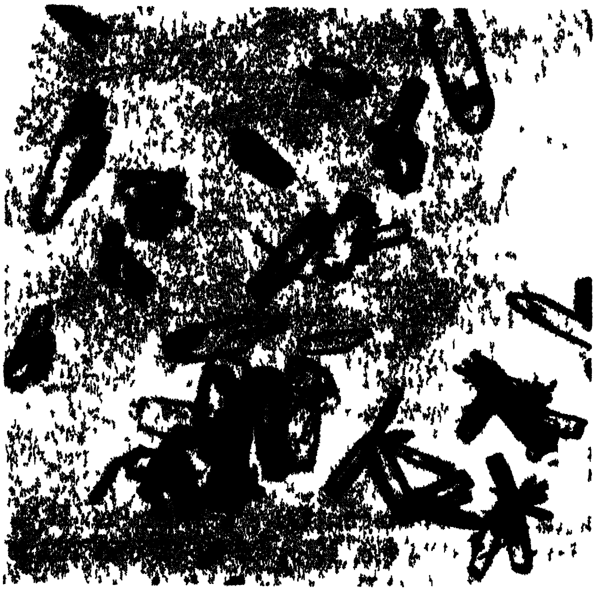
The substance had a bitter taste; it readily dissolved in water, methanol and acetic acid; it was soluble in ethanol and chloroform; it was sparingly soluble in acetone, benzol and ethyl-acetate and was insoluble in ether and petroleum-ether. A solution of octahydro-anhydro-isatidine in twice-normal hydrochloric acid gave strong precipitates with phospho-tungstic acid and with Mayer's, Wagner's and Dragendorf's alkaloidal reagents.

The formula $C_{18}H_{31}O_6N$ was definitely established by the preparation of the hydrochloride from this base and the isolation of the hydrochloride from the hydrogenated acid solution.

### *Isolation of Octahydro-anhydro-isatidine-hydrochloride.*

This compound was very readily obtained when isatidine was catalytically reduced in a normal hydrochloric acid solution (see above) and the filtrate after the hydrogenation allowed to evaporate in front of a fan at room temperature. Crystals rapidly began to separate in the form of stout prismatic columns. The liquid was finally evaporated to dryness on a water-bath. The crystals were dried, washed with acetone followed by ether and recrystallized from boiling ethanol. After two recrystallizations the hydrochloride (see Fig. 2) melted sharply at 218° with strong evolution of gas to a clear melt.

FIG. 2.



Octa-hydro-anhydro-isatidine-hydrochloride × 35.

*Optical Rotation.*

Wht........ .... = 50·0 mgm.

Vol... ..... .. .. .. .. = 7·5 c.c. $H_2O$.

$\theta$..... ............. = — 0·35.

$$\left[\alpha\right]_D^{20} = \frac{-0\cdot35 \times 7\cdot5 \times 1{,}000}{1 \times 50} = -52\cdot5^\circ.$$

*Micro-analysis:*

5·407 mgm.: 10·875 mgm. $CO_2$: 3·870 mgm. $H_2O$.
2·914 mgm.: 0·090 c.c. N at 23°C and 766 m.m. Hg.
13·420 mgm.: 4·940 mgm. AgCl.

Calculated for $C_{18}H_{31}O_6$ N.HCl C. = 54·88 per cent.: H = 8·19 per cent.
N = 3·55 per cent.: Cl = 9·00 per cent.
Found........................ C. = 54·87 per cent.: H = 8·01 per cent.
N. = 3·59 per cent.: Cl = 9·10 per cent.
Therefore.................... $C_{18}H_{31}O_6N.NCl$.

The substance was readily soluble in water, methanol and acetic acid; it was sparingly soluble in ethanol, ethyl-acetate and chloroform and it was insoluble in ether, acetone and petroleum ether.

### *Preparation of Octahydro-anhydro-isatidine (free base) from the above hydrochloride.*

The pure hydrochloride (m.p.218°) was dissolved in a small volume of water and the solution made alkaline with a concentrated ammonium hydrate solution (1:3 $H_2O$). It was then allowed to evaporate in front of a fan. The residue, which had the consistency of a syrup, was stirred with dry acetone when it became crystalline. Purification was effected by recrystallization from ethanol on the addition of a small volume of pure ether. The base had the same double melting-point and showed no depression when mixed with the free base directly isolated from the isatidine-hydrogenated solution (see page 436).

### *Hydrolysis of Octahydro-anhydro-isatidine and the Isolation of Tetrahydro-isatinecine.*

The hydrolysis of Octahydro-anhydro-isatidine can be effected in two ways: (1) immediately after the hydrogenation ($PtO_2$) of isatidine was completed, i.e., with the base still in normal hydrochloric acid solution, or (2) with the crystalline hydrochloride after its isolation. In the first case the filtrate, after 4 molecules of $H_2$ had been taken up by the isatidine in N-HCl solution, was shaken with ether. The ether was removed and the acid solution neutralized with concentrated ammonium hydrate (1:3 $H_2O$) and then 1·2 mol. of solid barium hydrate were added. In the second case the crystalline tetrahydro-anhydro-isatidine hydrochloride was dissolved in a small volume of water and a small excess of barium oxide-hydrate was then added.

The solution (in either case)with the barium hydrate was then refluxed for about one hour [e.g., 10 gms. octahydro-anhydro-isatidine and 12 gms. of $Ba(OH)_2 \cdot 8H_2O$]. It was then filtered. The filtrate was titrated with concentrated sulphuric acid (1:4 $H_2O$) until just acid to phenolphthalein. The $BaSO_4$ was centrifuged off. The clear supernatant was allowed to evaporate on a waterbath to dryness and the dry residue extracted with hot absolute alcohol. The alcoholic solution was then allowed to evaporate on a waterbath and the syrupy residue stirred with dry acetone. The base crystallized.

This substance was then repeatedly refluxed with acetone which removed the base and on the concentration of the acetone and the addition of a small volume of ether readily crystallized (see Fig. 3). After one or two similar recrystallizations this base tetrahydro-isatinecine, had a constant melting-point (sharp) of 174·5°. It is very hygroscopic.

FIG. 3.

Tetrahydro-isatinecine, m.p. 175×10.

*Micro-analysis :*

5·201 mgm.: 10·380 mgm.$CO_2$; 4·440 mgm. $H_2O$.

3·021 mgm.: 0·210 c.c.N at 25·5° C. and 754 m.m. Hg.

Calculated for $C_8H_{17}O_3N$:

$C = 54{\cdot}83$ per cent.; $H = 9{\cdot}78$ per cent.; $N = 7{\cdot}99$ per cent.

found:

$C = 54{\cdot}43$ per cent.; $H = 9{\cdot}55$ per cent.; $N = 7{\cdot}90$ per cent.

*Optical rotation.*

The mean value of a solution of 50·0 mgm. in 8·0 c.c. distilled $H_2O$ was found to be as follows:—

$\alpha = -0{\cdot}55°$.

Therefore $\left[\alpha\right]^{20}_{D} = -88{\cdot}0°$.

*Chemical Properties :*

This substance (tetrahydro-isatinecine) was easily soluble in cold water, ethanol, methanol and chloroform.

It readily dissolved in hot acetone; it was sparingly soluble in ethyl-acetate and practically insoluble in ether and petroleum-ether.

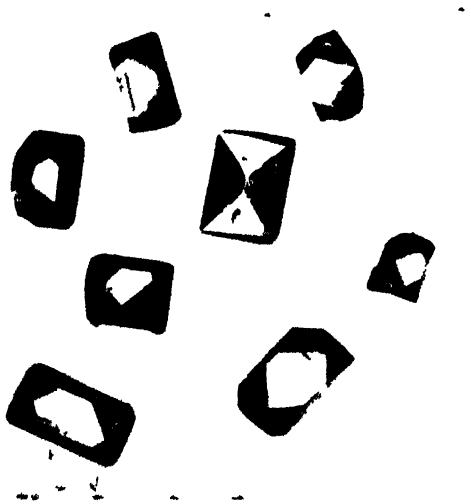
A solution of tetrahydro-isatinecine in two normal HCl gave strong precipitates with phosphotungstic acid and with Wagner's, Dragendorf's and Mayer's reagents. With Mayer's reagent lemon-yellow crystalline flakes were obtained with a crude melting-point of 117°. Tetrahydro-isatinecine was unstable towards soda-alkaline potassium-permanganate solution.

. *Barium-hydroxide hydrolosis of Isatidine.*[*] *The isolation of... isatinecine, isatinecic acid and isatinecic monolactonic acid.*

To a solution of 20 gms. of isatidine in 200 c.c. of water was added 20 gms. of solid barium-oxide-hydrate (1·2 mol.) and was then refluxed for 40 minutes. The filtrate was titrated with concentrated sulphuric acid (1:4 $H_2O$) until just acid to phenolphthalein and the $BaSO_4$ precipitate centrifuged off. The supernatant was decanted and evaporated on a waterbath under reduced pressure. The dry residue was then twice extracted with hot ethanol which readily removed the base isatinecine.

On concentration of the alcohol and the addition of acetone isatinecine crystallized out in a very good yield of about 8 gms. Thus recrystallized the basic fission product (see Fig. 4) decomposed at 212-215°.

FIG. 4.



Isatinecine, m.p. 212-5°, ×10.

*Micro-analysis.*

4·729 mgm. dried at room temperature in high vacuum over $P_2O_5$ lost 0·058 mgm. in weight.

(*a*) 4·671 mgm.: 9·655 mgm. $CO_2$; 3·160 mgm. $H_2O$.

---

[*] In a private communication Dr. J. J. Blackie of Edinburgh suggested the hydrolysis with $Ba(OH)_2$ for which we wish to express our sincere thanks.

(*b*) 2·865 mgm.: 0·214 c.c. N at 25° C. and 764 m.m. Hg. found: C = 56·41 per cent.; H = 7·57 per cent.; N = 8·6 per cent.

Calculated for $C_8H_{13}O_3N$: C = 56·12 per cent.; H = 7·65 per cent.; N = 8·2 per cent.

(*c*) Active hydrogen could not be determined due to the insolubility of the substance in either pyridine or anisole.

(*d*) Negative for C-methyl groups.

(*e*) Negative for N-methyl groups.

*Optical Rotation.*

$\left[\alpha\right]_D^{20} = +22\cdot4°$ (50·0 mgm. in 8 c.c. $H_2O$)

*Properties.*

Isatinecine gave strong precipitates with phosphotungstic acid, Wagner's and Dragendorf's reagents, but nil with Mayer's reagent.

It is soluble in water, methanol, ethanol and acetic acid.

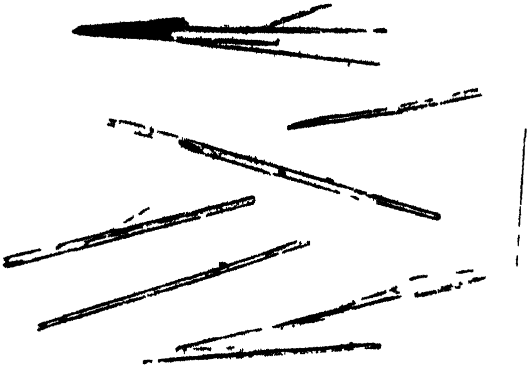
It is sparingly soluble in acetone and ethyl-acetone and practically insoluble in ether, petroleum-ether and chloroform.

### *Isolation of Isatinecic Acid and Isatinecic Monolactonic Acid.*

The residue after the extraction of the base with ethanol (above) was then dissolved in a small volume of water, titrated with concentrated sulphuric acid (1 : $4H_2O$) until the solution was this time just acid to congo red. The $BaSO_4$ was again centrifuged off and the supernatant evaporated to dryness as already stated for the base above. The dry residue was then refluxed with ethyl-acetate for two to three minutes which removed the acid, the ethyl-acetate solution was dried over exsiccated $Na_2SO_4$ and if necessary decolourised by the addition of a pinch of charcoal. On the addition of a little petroleum-ether to the filtrate isatinecic acid crystallized in needles. After a similar recrystallization the acid crystallized in fairly large beautiful colourless needles (see Fig. 5) with a clear constant melting-point of 148·5°.

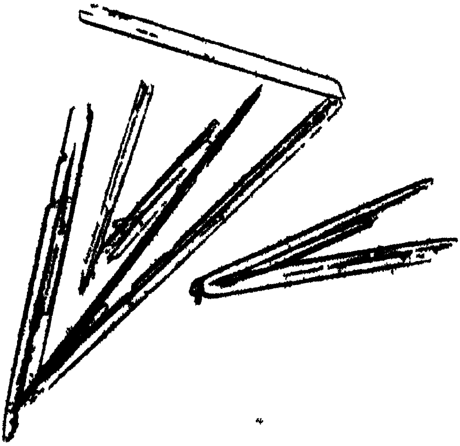
When similar hydrolysis experiments of isatidine with barium-hydroxide were carried out under slightly excessive heat, the hydrolysis invariably resulted in the isolation of the isatinecic monolactonic acid. This monolactonic monobasic acid readily crystallizes into beautiful large crystals (see Fig. 6) from pure ethyl-acetate only. After the third recrystallization the substance was pure with a sharp melting-point at 197-8° C.

FIG. 5.



Isatinecic acid, m p 148 5, ×5

FIG 6.



Isatinecic monolactonic acid, m p 197-8, ×10.

*Micro-analysis of Isatinecic Acid.*

(*a*) The inactive acid and (*b*) the active acid $\left[\alpha\right]_D^{20} = +86(H_2O)$

(*a*) 4·260 mgm.: 8·100 mgm. $CO_2$; 2·640 mgm. $H_2O$.

(*b*) 5·476 mgm.: 10·410 mgm. $CO_2$; 3·410 mgm. $H_2O$.
found (*a*): C = 51·88 per cent.; H = 6·94 per cent.
found (*b*): C = 51·87 per cent.; H = 6·97 per cent.
Calculated for $C_{10}H_{16}O_6$: C = 51·72 per cent.; H = 6·94 per cent.

(*c*) 0·201 mgm. in 3·027 mgm. camphor; $\Delta = 11\cdot2°$.
therefore mol. weight = 238.
$C_{10}H_{16}O_6 = 232\cdot23$.

(*d*) *Active H Determination (Zerewitinoff).*

(1) 6·210 mgm.: Vo = 1·23 c.c. $CH_4$.
(2) 6·301 mgm.: Vo = 1·25 c.c. $CH_4$.
found (1) = 0·88 per cent. reactive H atoms.
found (2) = 0·88 per cent. reactive H atoms.
Calculated = 0·86 per cent. for two reactive H atoms.
therefore2 – OH groups.

(*e*) Micro-titration.

54·0 mgm. of the dibasic acid dissolved in about 5 c.c. $H_2O$ required 4·60 c.c. N NaOH.

Now 23·2 mgm. (mol.wht.232) required 2·0 c.c. N NaOH for 2-COOH.

Therefore 54 mgm. required 4·66 c.c. NaOH for 2-COOH.

Therefore 2 carboxyl-groups.

No lactonic groups were found to be present.

(*f*) *Solubility.*

Isatinecic acid immediately dissolved in cold water, cold methanol, cold ethanol, cold acetone and cold acetic acid. It was soluble in ethyl-acetate and practically insoluble in ether, petroleum-ether and chloroform.

### *Chemical Properties of Isatinecic Monolactonic Acid.*

1. *Micro-analysis.*

5·311 mgm.: 10·945 mgm. $CO_2$; 3·142 mgm. $H_2O$.
found: C = 56·22 per cent.; H = 6·63 per cent.
Calculated for $C_{10}H_{14}O_5$: C = 56·08 per cent.; H = 6·59 per cent.

(2) *Micro-titration.*

50·0 mgm. acid dissolved in about 5 c.c. $H_2O$. required 2·30 c.c. N NaOH.

Now 21·4 mgm. (mol.wht.214) required 1·0 c.c. N NaOH for 1-COOH.

Therefore 50·0 mgm. required 2·32 c.c. NaOH for 1-COOH.

Therefore one carboxyl group.

(3) *Saponification.*

4 c.c. $\frac{N}{10}$ NaOH was added to the titrated solution (2), and this solution then refluxed for 30 minutes.

Back titration required 1·85 c.c. $\frac{N}{10}$ HCl.

Therefore difference – 2·15 c.c. $\frac{N}{10}$ NaOH.

Therefore monobasic-monolactonic-acid.

Theory for one lactone-group = 2·32 NaOH.

(4) *Specific Rotation* (mean of several determinations).

Weight = 50·0 mgm.

Volume = 8·0 c.c. $H_2O$

$$\alpha = +0{\cdot}68^\circ$$

$$\left[\alpha\right]_D^{20} = \frac{+\,0{\cdot}68 \times 1000 \times 8}{1 \times 50}$$

$$= +108{\cdot}8^\circ.$$

(5) *Solubility.*

The isatinecic monolactonic acid dissolved in cold water, cold methanol, cold ethanol and cold acetone, but not so readily as the dihydroxy-dibasic isatinecic acid. It dissolved in ethyl-acetate and acetic acid, but was practically insoluble in ether, petroleum-ether and chloroform.

### *Alcoholic KOH Hydrolysis of Isatidine.*

### *The Isolation of the "New" Isomeric Acid,* $C_{10}H_{16}O_6$.

In the first paper of this series (de Waal, 1939), the hydrolysis of isatidine with alcoholic potassium hydroxide had been recorded and the isolation of the acid fission product only had been described. The following improved hydrolysis led to the isolation of both the base and the acid.

To 10 gms. of isatidine dissolved in 80 c.c. ethanol was added 4 gms. of solid KOH (= 1·3 mol.) and then boiled under a reflux condenser. (The addition at this stage in another experiment of 2 c.c. of water led to the same hydrolysis results.) Within 5 minutes crystals separated and after 10 minutes the contents of the flask was one mass of crystals. The hydrolysis was stopped and the crystals were filtered off, thoroughly washed with ethanol and dried. This substance was the dibasic potassium salt of the inactive acid. [From the alcoholic filtrate isatinecine was isolated adopting the same procedure as described further above for the $Ba(OH)_2$ hydrolysis.]

### *Isolation of the Acid.*

The potassium crystalline salt was dissolved in about 20 c.c. of cold water and the solution divided into two equal portions. The one portion was neutralized with concentrated sulphuric acid (1:4 $H_2O$) until just acid to congo red and the other portion neutralized with concentrated hydrochloric acid (1:3 $H_2O$) again until just acid to Congo red. (The object was to test whether $H_2SO_4$ would lead to the isolation of a dibasic acid and HCl to the isolation of a monobasic monolactonic acid.) From both filtrates on evaporation crystals separated. The crystallization was more rapid and complete from the $H_2SO_4$ neutralized solution. In both instances one and the same dibasic acid crystallized, identical with the dibasic acid already described in the first publication (1939). With solid KOH the isolated acid was found to be inactive, whereas formerly with twice normal alcoholic potassium hydroxide the optically active dibasic acid was isolated. The melting of this acid is 181·5° corrected (not 178-180° as was reported previously).

## SUMMARY.

1. The principle alkaloid of *Senecio isatideus* D.C. isatidine, $C_{18}H_{25}NO_7$, on hydrogenation in the presence of platinum-dioxide, took up 8 atoms of hydrogen with the elimination of one molecule of water. The formula is $C_{18}H_{31}O_6N$, m.p. 183-184° C.

2. The hydrogenated crystalline substance, octahydro-anhydro-isatidine, readily forms a hydrochloride m.p. 218° C., $[\alpha]_D^{20} = -52{\cdot}5(H_2O)$, and can easily be converted into the free base.

3. Octahydro-anhydro-isatidine or its hydrochloride yields on hydrolysis with $Ba(OH)_2$ a new basic fission product with the formula $C_8H_{17}O_3N$. Isatinecine has the formula $C_8H_{13}O_3N$. It is therefore a tetrahydro-isatinecine.

4. Tetrahydro-isatinecine, m.p. 175° C. and $[\alpha]_D^{20} = -88°$; is unstable towards potassium-permanganate and gives positive reactions with alkaloidal reagents.

5. Isatidine hydrolysed with $Ba(OH)_2$ yields isatinecine and the dihydroxy-dibasic isatinecic acid formulae $C_8H_{13}O_3N$ and $C_{10}H_{16}O_6$ respectively.

6. When isatidine is hydrolysed with alcoholic KOH the same base isatinecine, but a different dibasic acid is obtained, isomeric with isatinecic acid. It has m.p. 181·5° C.

7. Isatinecic acid readily forms a monobasic monolactonic acid, $C_{10}H_{14}O_5$, m.p. 197-8° and $[\alpha]_D^{20} = +108{\cdot}8°$ $(H_2O)$.

8. Both isatinecic acid and its "new" isomeric acid each take up four atoms of hydrogen on hydrogenation in the presence of $PtO_2$.

9. From the hydrolysis results with octahydro-anhydro-isatidine and the isolation of the basic fission product tetrahydro-isatinecine, $C_8H_{17}O_3N$, it is concluded, that it must be the acidic fraction of the hydrogenated molecule which eliminates one molecule of water as follows:—

$$C_{10}H_{16}O_6 + 4H_2 = C_{10}H_{20}O_6.$$
$$C_{10}H_{20}O_6 - H_2O = C_{10}H_{18}O_5.$$
$$C_8H_{17}O_3N + C_{10}H_{18}O_5 = C_{18}H_{31}O_6 + 2H_2O.$$

10. The work is being continued with the view to furnish a further contribution towards the structure of the Senecio alkaloids.

## ACKNOWLEDGEMENT.

The micro-analyses (C—H, N, Cl, active H, N—$CH_3$, C—$CH_3$) were carried out by Dr. A. Schoeller, Berlin, and Dr. K. Wallenfels, Heidelberg, Germany. The photographs were taken by Mr. T. Meyer, Onderstepoort. I would like to thank these gentlemen sincerely for their assistance.

## AUTHOR'S NOTE.

After this article had been submitted to the Press it was discovered that isatinecic acid is a per acid, i.e., has one -R.CO.O.OH group and that this is ester-linked in isatidine. Therefore both isatidine and isatinecic acid have each one per-oxygen atom, accounting for one excess hydrogen molecule during their hydrogenations above those required for the saturation of olefine double-bonds. (A more detailed article will appear in a subsequent issue of this journal.)

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# Section VII.

# Chemical Blood Studies.

ROETS, G. C. S. ... ... spectroscopic method for (A) the Chemical blood studies VIII. A rapid quantitative determination of haemoglobin in blood and (B) its application for the quantitative estimation of haemoglobin in milk, urine, serum or plasma and faeces ... ... ... ... ... 451

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# Chemical Blood Studies VIII.

## A Rapid Spectroscopic Method for (A) The Quantitative Determination of Haemoglobin in Blood and (B) Its Application for the Quantitative Estimation of Haemoglobin in Milk, Urine, Serum or Plasma and Faeces.

By G. C. S. ROETS, Department of Chemical Pathology,
Onderstepoort.

In connection with animal pigment metabolism studies the author and his collaborators needed a rapid and efficient method for estimating haemoglobin quantitatively in biological materials. In this communication such a method is recorded, by which the blood haemoglobin and haemoglobin present in milk, urine, serum or plasma and faeces can be quantitatively estimated.

### A.—THE QUANTITATIVE DETERMINATION OF HAEMOGLOBIN IN BLOOD.

### *Methods considered.*

Newcomer, H S. (1919) proposed a haemoglobinometer, with a coloured glass disc as a standard for the quantitative determination of haemoglobin as acid haematin. In 1923 he advocated the use of a modified Duboscq colorimeter. This method, known as the Newcomer disc method, is in common use. Cohen, B and Smith, A. H. (1919) used an Autenrieth-Hellige or Duboscq colorimeter for matching the colour against that of a standard acid haematin solution.

Another technique was developed by Wong, S. Y. (1922) by which the iron present in the blood is determined and from this the total amount of haemoglobin is calculated, the assumption being that iron, apart from that contained in the haemoglobin molecule is present only in traces in blood. In 1928 he described how the iron of the haemoglobin molecule can be detached by the action of sulphuric acid, the decomposition being facilitated with the aid of potassium persulphate. The interfering proteins are completely precipitated by tungstic acid and filtered off. Colorimetric comparisons are made against a standard iron solution. Andes, J. E. and Northup, D. W. (1938) made use of a photoelectric colorimeter for the comparisons. Hanzal, R. F. (1933) determined the iron by digesting blood with sulphuric acid and hydrogen peroxide over a microburner, and by comparing the characteristic colour obtained with thioglycolic acid and ammonium hydroxide against that of a standard iron solution similarly treated. The last mentioned method was preferred by the author on account of its extreme sensitivity and the elimination of the filtering process. Myers, V. C. and Eddy, H. M. (1939) described slight modifications to permit its use with 0·05 c.c. of blood.

Dénes, A. (1932) established a spectrophotometric method for measuring the 555·8 $\mu\ \mu$ and 527·1 $\mu\ \mu$ haemochromogen absorption bands ratio. From the extinction coefficients of these two wavelengths of the spectrum and the absorption ratio, the haemoglobin content of the blood can be calculatetd. The haemin content of liver catalase preparations was determined by Stern, K. G. (1937) by converting the haemin into pyridine haemochromogen and comparing the intensity of the absorption bands against that of a standard prepared from crystalline blood haemin. The same principle had been used by Zeile, K. and Hellström, H. (1930) and also by Keilin, D. and Hartree, E. F. (1936).

The intensity of the 555 absorption band of Pyridine haemochromogen is made use of in my method; a Zeiss pocket spectroscope and the principle of dilution as described by Rimington, C., Roets, G. C. S. and Fourie, P. J. J. (1938) in the quantitative determination of coproporphyrin being used.

## *Procedure.*

*Stock Solution.*—Dissolve 116·6 mg. pure recrystallised haemin in 40 c.c. pyridine and dilute up to 100 c.c. with ·1N NaOH solution.

*Standard.*—A dilution of 0·5 c.c. stock solution up to 100 c.c. with ·1N NaOH serves as a standard solution.

*Blood.*—*Transfer* 0·4 c.c. oxalated blood into a 200 c.c. measuring flask, add ·1N NaOH up to the mark, shake thoroughly and leave at room temperature for 10 minutes.

*Comparison.*—Take two similar thin glass test tubes 1·5 cm. in diameter, and measure off 5 c.c. of the standard solution into the one and 5 c.c. of the blood solution into the other. To each of the tubes add 1 c.c. pyridine and a few mg. sodium hydrosulphite. Compare the intensity of the 555 absorption bands and dilute the solution showing the more intense band (whether standard or unknown) with a ·1N NaOH solution by means of a calibrated standard pipette until equal intensity is reached in both tubes. After each dilution the solution should be thoroughly mixed by lateral shaking.

### *Calculations.*

M. wt. of haemoglobin = 66,800.

The haemoglobin molecule has four haematin molecules [see Hawk and Bergeim (1931)].

Haemin = $C_{34}H_{32}O_4N_4$ FeCl.

Thus the concentration haemoglobin equivalent to the standard

$$\text{solution} = 116{\cdot}6 \times \frac{66800}{651{\cdot}329 \times 4} \times \frac{{\cdot}5}{100} \text{ mg. per 100 c.c.}$$

$$= 14{\cdot}95 \text{ mg. or } 0{\cdot}01495 \text{ g. per 100 c.c.}$$

In the unknown, the amount of haemoglobin expressed as grams haemoglobin per 100 c.c. blood

$$= \frac{x}{6} \times \frac{200}{0{\cdot}4} \times 0{\cdot}01495$$

$x$ = Volume in c.c. to which the unknown is diluted

$$\text{or } = \frac{6}{y} \times \frac{200}{0{\cdot}4} \times 0{\cdot}01495$$

where $y$ = Volume in c.c. to which the standard is diluted.

*Precautions.*—The addition of too much sodium hydrosulphite produces a slight turbidity, which may result in too high values. With experience the exact quantity necessary can easily be judged.

Fresh stock solutions should be made up monthly and kept in the dark since decomposition takes place. Standard solutions should be made up daily.

## *Discussion.*

As a check on this method simultaneous determinations were made by the iron method as described by Hanzal and by the Newcomer disc method. The results obtained by the former compared quite satisfactorily whilst those of the last mentioned method did not. Andes and Northup (1938) had the same experience when comparing the results obtained by Wong's method and the Newcomer disc method.

The following table shows comparative results obtained by these three methods.

TABLE I.

*Comparison of the Haemoglobin Values by the Three Methods.*

| Animal Species. | Iron Method. g. Hb. per 100 c.c. Blood. | Spectroscopic Method. g. Hb. per 100 c.c. Blood. | Newcomer Disc Method. g. Hb. per 100 c.c. Blood. |
|---|---|---|---|
| Sheep normal.................. | 12·61 | 12·57 | 14·31 |
| Bovine normal.................. | 11·47 | 11·42 | 12·61 |
| Bovine normal.................. | 11·78 | 11·42 | 13·06 |
| Bovine normal.................. | 11·48 | 11·82 | 14·04 |
| Bovine normal.................. | 11·48 | 11·82 | 13·78 |
| Bovine normal.................. | 12·10 | 12·37 | 15·18 |
| Bovine normal.................. | 15·71 | 14·93 | 16·87 |
| Bovine normal.................. | 12·10 | 12·46 | 12·61 |
| Bovine normal.................. | 10·92 | 10·59 | 10·87 |
| Bovine anaplasmosis............ | 4·14 | 4·08 | 6·11 |
| Bovine anaplasmosis............ | 6·22 | 6·85 | 5·08 |

With the necessary practice and sufficient equipment 70 to 100 determinations can easily be made during an eight hour working day.

The accuracy and simplicity will undoubtedly be increased with a more efficient spectroscopic apparatus. The author attached a Zeiss microspectroscope ocular with a comparison prism to a microscope and transferred the standard solution to a tube in front of the comparison prism which was illuminated with a mirror in a fixed position. The stratum of the standard in a little beaker on the microscope stage was adjusted by addition until equal intensity in both spectra was reached. The unknown was now diluted with known quantities and replaced in the tube in front of the comparative prism until equal intensity was once more reached. Better results were not obtained. Similar apparatuses for comparing spectra intensities were designed by Stern, K. G. (1937) and Keilin, D. and Hartree, E. F. (1936) where the strata of liquids could be altered by movable plungers similar to the principle employed in ordinary colorimeters.

## (B) THE APPLICATION OF THIS PYRIDINE HAEMOCHROMOGEN METHOD TO THE QUANTITATIVE ESTIMATION OF HAEMOGLOBIN IN MILK, URINE, SERUM OR PLASMA AND FAECES.

### *Methods Considered.*

Numerous methods for the qualitative detection of blood in biological materials can be traced in physiological and biochemical text books like those of Hawk, P. B. and Bergeim, O. (1931), Plimmer, R. H. A. (1918) and White, D. S., and Fischer, P. (1920). These methods can be classified into four groups:—

(1) *Peroxidase Reactions.*—Haemoglobin reacts upon peroxide giving off oxygen. Oxygen thus liberated gives marked colour reactions with substances of the following type:—

(*a*) Guaiacum—blue.
(*b*) Aloin—purple-red.
(*c*) Benzidine—blue-green.
(*d*) Malachite green—green.
(*e*) p-Phenylenediamine hydrochloride—brown-red.
(*f*) Phenolphthalein—red.
(*g*) Ortho-toluidin—bluish.

These tests, with all their modifications, are based on the same property of haemoglobin. Thus any substance which liberates oxygen in the same way as haemoglobin, will give a positive reaction. In practice, therefore, pus, milk, faeces, etc., very often give a positive result in the absence of haemoglobin.

(2) *The microscopic identification of erythrocytes.*—This method is one of the best when non-haemolysed blood is present, for then liquid materials such as urine and milk can be centrifuged and the sediment examined microscopically for erythrocytes.

(3) *The conversion of haemoglobin into haematin.*—(*a*) In the potassium hydroxide test (Heller) the red colour of haematin is made use of to detect the presence of blood. This test is very unsatisfactory since many other substances like porphyrins, for example, may contribute to a red colour of the solution.

(*b*) The crystals of haematin can easily be prepared by the acetic acid method and microscopically identified. This is a specific test but the very small quantities to be dealt with in practice makes this method often impracticable.

(4) *Spectroscopic examination.*—The spectroscopic examination of translucent materials like lymph, serum, plasma or urine is one of the most satisfactory ways by which haemoglobin can be detected in such materials.

The method described in this article makes it possible to detect haemoglobin in concentrations as low as 4 mg. haemoglobin per 100 c.c. liquid, on account of the extreme intensity of the 555 band of pyridine haemochromogen.

### *Procedure.*

(1) *Milk.*—Shake the milk sample thoroughly to obtain an even distribution of erythrocytes, which might have gravitated towards the bottom of the container on standing. Transfer 30 c.c. to a calibrated centrifuge tube, add a few mg. saponin, stir well with a glass rod and leave at room temperature for 30 minutes. Add 0·3 c.c. of strong hydrochloric, stir well and centrifuge for 15 minutes. Note the volume of the liquid. Measure off 10 c.c. of this liquid into a centrifuge tube, add 2 c.c. of pyridine, mix well and centrifuge for 10 minutes. To 6 c.c. of the supernatant liquid is added sodium hydrosulphite. The comparison is now made.

*Calculation.*

$$\frac{x}{6} \times \frac{y}{30} \times 14{\cdot}95 \text{ mg. haemoglobin per 100 c.c.}$$

$x$ = Volume in c.c. to which the unknown is diluted.

$y$ = Volume in c.c. of the liquid phase.

or

$$\frac{6}{z} \times \frac{y}{30} \times 14{\cdot}95 \text{ mg. haemoglobin per 100 c.c.}$$

where $z$ is the volume in c.c. to which the unknown is diluted.

Thus 30 c.c. of a milk sample containing blood equivalent to 27·41 mg. haemoglobin per 100 c.c. yielded 25 c.c. of liquid after being centrifuged. 6 c.c. of the final liquid after being treated with pyridine and centrifuged had to be diluted up to 13 c.c. to match the standard.

$$\text{Haemoglobin found} = 14{\cdot}95 \times \frac{13}{6} \times \frac{25}{30} \text{ mg. per 100 c.c.}$$

$$= 26{\cdot}99 \text{ mg. per 100 c.c.}$$

The haemoglobin of the erythrocytes in fresh milk can be determined as follows: Centrifuge a known volume of the sample for 30 minutes, decant off the liquid carefully, lake the sediment with a 0·05 per cent. saponin solution (1 to 5 c.c. or more) and perform the test as above.

It was observed that the haemoglobin concentrations decreased in the course of time. The following experiment was therefore carried out:—

2·5 c.c. of a solution containing 4·96 g. haemoglobin per 100 c.c. was made up to 500 c.c. with milk. This mixture was thoroughly shaken. 250 c.c. was exposed in an open flask at room temperature and 250 c.c. was stored in an open flask in the ice chest. Tests were carried out on these two samples and it was found that the haemoglobin concentrations decreased equally in both flasks. Table II shows the percentage decrease at different periods.

TABLE II.

| *Time in hours.* | *Percentage decrease.* |
|---|---|
| 2 | 3·5 |
| 5 | 24·5 |
| 24 | 62 |
| 72 | 74·5 |
| 96 | 80·4 |

It is therefore necessary to examine milk within two hours after withdrawal from the udder to avoid too large an error. Furthermore the rate of haemoglobin destruction may vary considerably in different milks, whether from normal or diseased udders, and this point merits further investigation.

(2) *Urine and serum (or plasma).*—Measure off 10 c.c. into a centrifuge tube, add 2 c.c. of pyridine, mix well and centrifuge for 10 minutes. The test is performed on 6 c.c. of the clear supernatant fluid as previously described.

*Calculations.*

$14{\cdot}95 \times \frac{x}{6}$ mg. per 100 c.c.

Where $x$ = Volume in c.c. to which the unknown is diluted.

or $14{\cdot}95 \times \frac{y}{6}$ mg. per 100 c.c.

where $y$ = Volume in c.c. to which the standard is diluted.

The haemoglobin concentration in a normal human urine to which blood had been added, remained constant within the limits of experimental error, for at least 5 hours, but decreased by 34 per cent. and 66·9 per cent. after 2 and 7 days respectively. The haemoglobin concentration in urine should therefore be estimated as soon as possible after collection.

(3) *Faeces*.—Grind in a mortar 5 grams fresh faeces with 30 c.c. of a 0·05 per cent. saponin solution, leave at room temperature for 15 minutes and centrifuge for 15 minutes. Pipette off 10 c.c. of the liquid, add 2 c.c. of pyridine and a pinch of sodium chloride, stir well and centrifuge for 15 minutes. The test is performed on 6 c.c. of this solution.

*Calculations.*

$$14{\cdot}95 \times \frac{x}{6} \times \frac{30}{5} \text{ mg. per 100 g. faeces.}$$

Where $x$ = Volume in c.c. to which the unknown is diluted.

$$\text{or } 14{\cdot}95 \times \frac{6}{y} \times \frac{30}{5} \text{ mg. per 100 g. faeces,}$$

where $y$ = Volume in c.c. to which the standard is diluted.

It should be noted that a possible haemoglobin destruction may also take place in faeces, and to investigate this possibility the following experiment was conducted:—

0·3 c.c. quantities of a solution of blood in distilled water (4·485 g. haemoglobin per 100 c.c.) were added to 5 g. samples of fresh haemoglobin-free bovine faeces; thus the theoretical amount in each sample should be 269 mg. per 100 g. faeces.

Concentration found = 284 mg. per 100 g.

After the samples had been left at room temperature for 2 hours it was 268 mg. per 100 g. A further decrease of 30 per cent. was found after 24 hours. To obtain the most reliable concentration, estimations should therefore be made as soon as possible after sampling, preferably within 2 hours after defaecation.

In applying this pyridine haemochromogen method for the quantitative estimation of haemoglobin in milk, urine, serum or plasma and faeces a slight opalescence or other pigments apart from haemoglobin may interfere with the penetration of light to a certain extent. The pyridine haemochromogen, however, has such an intense absorption band that this defect is not a serious one. It should also be kept in mind that methaemoglobin, which is frequently encountered is also converted into the pyridine haemochromogen.

## SUMMARY.

A spectroscopic method for the quantitative determination of the haemoglobin content of blood is described. The haematin is converted into pyridine haemochromogen and a comparison of the intensity of the 555 absorption band made against a known standard. Haemoglobin can be quantitatively estimated in milk, urine, serum, plasma or faeces.

## ACKNOWLEDGMENT.

I wish to thank Dr. H. Graf, Head of this Department, for his interest and encouragement in this work.

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# Section VIII.

# Wool Research.

Rossouw, S. D. . ... The origin of sulphur in wool, III. An improved cuprous mercaptide method for the determination of cystine in material low in cystine ... 461

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# The Origin of Sulphur in Wool.—III. An Improved Cuprous Mercaptide Method for the Determination of Cystine in Material low in Cystine.

By S. D. ROSSOUW, Wool Research Section, Onderstepoort.

In a previous paper (Rossouw and Wilken-Jorden, 1935), it was shown that cystine can be precipitated as the cuprous mercaptide, thus eliminating many substances which Rossouw and Wilken-Jorden (1934) found to interfere with the determination. In certain cases sulphuric acid instead of hydrochloric acid hydrolysates were used and excessive humin formation was eliminated, also little or no oxidation to cysteic acid took place as found by Lugg (1933). It can be safely said that with the present available methods it will be impossible to detect cystine in a hydrochloric acid hydrolysate of substances in the nature of grasses, which are low in cystine. Andrews (1933) found traces of copper to oxidise cystine in hydrochloric acid solutions but not in sulphuric acid.

In the present modification the amino acid is determined as cysteine, resulting in double sensitivity and also eliminating all interfering colouration in the same process. Where excessive colouring material is present as is the case with hydrolysates of some grasses and blood, this method simplifies the process and leaves a better margin of safety. Many of the interfering substances found by Andrews and Andrews (1936) are thus eliminated from these hydrolysates. In grasses of low cystine content it is, however, advisable to reprecipitate the mercaptide, but as will be shown, this is quick and safe with an excellent regain.

## METHOD.

The method described, applies to grasses which are low in cystine as found by Rossouw (1935).

To 9 grams of grass dried to constant weight in an oven at 105° C. is added 80 ml. of 10 N sulphuric acid. This is warmed on a medium heat hot plate until the material is well soaked. The flask with the material, whilst still hot is covered with a beaker and placed in a gas heated autoclave controlled at 130° C. It is kept at this temperature for 5 hours. The hydrolysate is filtered hot through a G3 or G2 Jena fritted glass filter funnel, washed with hot water and made up to 200 ml. Depending on the cystine content, 50 to 100 ml. of this solution is measured into a 500 ml. flask and as a buffer 2 ml. glacial acetic acid is added. With 5 N. sodium hydroxide this solution is then brought to pH 4·6. A flocculent precipitate results which is filtered off through a G4 Jena filter and washed with dilute acetic-acid-sodium acetate buffer at pH 4·6. Medes and Padis (1936). To this filtrate is added, with gentle shaking, 0·5 to 1 ml. of freshly prepared solution of cuprous chloride in 25 per cent. potassium chloride. After one hour standing flocculation of the cystine cuprous mercaptide will be complete. For quickest and safest precipitation a temperature of 30° to 35° appears to be best.

The solution is then centrifuged simultaneously in two or more centrifuge tubes of the conical type. The solution containing the precipitate should be disturbed as little as possible, as this precipitate is apparently soluble in cupric chloride.

At this stage, depending on the amount of dark material present, two procedures are possible:—

(1) When excess of dark material is present: Here reprecipitation is resorted to. The precipitate in the tubes is dissolved in 4 ml. of 0·3 N. hydrochloric acid and washed with water into a 50 ml. centrifuge tube. To this solution is added about 200 mg. of pure zinc dust and the contents well stirred or gently shaken until foaming has subsided. This is then filtered and washed into another 50 ml. tube. The reduced solution is now much lighter. At the same time a standard solution containing 0·8 mg. of cystine in a decinormal solution of hydrochloric acid is pipetted into another centrifuge tube and treated similarly to the above. The volumes are made up to about 30 ml. each and the tubes placed in a water bath at about 30°. To the assay and the standard are each added 5 ml. of acetic acid-sodium acetate buffer and 10 per cent. potassium hydroxide dropwise to pH 4·6. To each is now added 0·25 ml. 25 per cent. potassium chloride followed by 6 drops (about 0·2 ml.) of freshly prepared cuprous chloride reagent. This is done dropwise with gentle shaking. Flocculation usually sets in after a few minutes. The tubes are left in the bath for about one hour and then centrifuged.

(2) When less dark material is present: When reprecipitation is not made use of the precipitates should be washed in a 4·6 pH buffer solution consisting of a mixture of acetic acid and sodium acetate. The washings are combined in one tube and centrifuged. A standard is prepared as already described in (1).

Whichever procedure has been followed, the precipitates of the assay and of the standard are separately dissolved in 4 ml. of a 0·3 N. solution of hydrochloric acid. To each solution is added 100 to 200 mg. of zinc dust and it is well stirred or gently shaken. During this process the temperature is kept below 15°. The reaction is allowed to continue for half an hour with frequent stirring or shaking. Each solution is then washed into a 20 ml. measuring cylinder and 2·5 ml. of a 2·5 per cent. acetic acid followed by 1·0 ml. of a 15 per cent. solution of potassium sulpho-cyanide is added.

The contents are mixed and 0·25 ml. pyridine is added dropwise. It is shaken and made up to 20 ml., keeping the temperature constant at 15°. It is then immediately filtered and 5 ml. aliquots used for the cystine determination. To aliquots of both standard and assay is now added 0·5 ml. of 10 per cent. potassium hydroxide solution and the temperature raised to 18° to 20°. As described by Rossouw and Wilken-Jordan (1934) 2 ml. 10 per cent. aqueous solution of sodium cyanide is then immediately added. After an interval of 10 minutes 1 ml. of a 0·5 per cent. aqueous solution, of 1,2-naptho-quinone-4-sodium sulphonate is added, the solution is gently shaken and 5 ml. of 10 per cent. anhydrous sodium sulphite in 0·5 N. sodium hydroxide added after 20 seconds. After mixing the solutions are allowed to stand for 40 to 60 minutes at 18° to 20° when 1 ml. of a 1 per cent. solution of sodium Hydrosulphite ($Na_2S_2O_4$) in 0·5 N. sodium hydroxide is added. The colours are immediately compared colorimetrically.

## REAGENTS.

1. 10 N. sulphuric acid.

2. 10 Per cent. solution of potassium hydroxide.

3. Merck's pure cuprous chloride. If this is visibly oxidised to cupric chloride it is best to purify a small sample to last for about a month as follows: The oxidised product is dissolved in a minimum quantity of 3 N. hydrochloric acid and a large excess of water is then added which precipitates the pure white cuprous chloride. The solution is quickly filtered through a G 3 filter, the precipitate washed with ethanol and placed in a vacuum at about 40° until dry.

0·5 Gm. of this powder is transferred to a stoppered cylinder, 13 ml. of 25 per cent. potassium chloride in decinormal hydrochloric acid added and the contents well shaken to dissolve. This solution is covered with a thin layer of petroleum ether and should last for a day.

4. 0·3 N Hydrochloric acid solution.

5. Merck's pure zinc dust.

6. 4·6 pH Buffer solution of Medes and Padis (1936) made up by using equal volumes of 2 M sodium acetate and 2 M acetic acid.

7. 2·5 per cent. solution of acetic acid.

8. 15 Per cent. solution of potassium sulphocyanide.

9. Pyridine, redistilled.

10. 10 Per cent. freshly prepared aqueous solution of sodium cyanide.

11. 1 Per cent. freshly prepared aqueous solution of 1,2-naphtho-quinone-4-sodium sulphonate. This material should be tested for purity as described by Sullivan (1926).

12. 10 Per cent. freshly prepared solution of anhydrous sodium sulphite in 0·5 N sodium hydroxide.

13. 1 Per cent. *freshly prepared* solution of sodium hydro sulphite in 0·5 N sodium hydroxide.

## Discussion.

Under the conditions of hydrolysis described above there is a cystine recovery of more than 90 per cent. when 2 mg. cystine is added to a sample of lucerne hay as indicated in the following table:—

| Temperature of Autoclave. | Time of Hydrolysis in Hours. | Cystine Content in mg. per cent. | Percentage regain of added Cystine. |
|---|---|---|---|
| 122° | 7·0 | 101 | 95 |
| 125° | 5·5 | 117 | 91 |
| 130° | 6·0 | 106 | 93 |
| 136° | 2·5 | 91 | 57 |

During hydrolysis the normality of the acid is reduced to about 8·5 N. When hydrolysed for too long a period or at too high a temperature the cystine figures will be too low due for instance to carbonisation, oxidation, etc. A temperature of 125° and hydrolysis for about 6 hours have been found satisfactory. The addition of zinc during hydrolysis is unnecessary in the case of sulphuric acid in contrast to hydrochloric acid but if resorted to the results are not effected.

The cystine cuprous mercaptide is soluble in cupric chloride. It was established that with vigorous shaking of the stoppered centrifuge tube containing the precipitating reagent all the mercaptide would dissolve in the cupric chloride formed. As a result of this oxidation it was decided to resort to centrifuging rather than risking filtration.

Probably due to traces of copper salt in solution the cysteine set free by the zinc dust reduction is apt to be oxidised to cystine but at 15° such cysteine solution will remain stable for 24 hours.

An additional cystine standard (direct standard) can be used as a check to that already described (indirect standard) by omitting the reduction of cystine to cysteine and remembering that in this case the colour intensity will be only half that of the indirect standard.

It was found necessary to control the temperature during the colour development carefully. At 18°-20° C. the colour development is much slower than at the usual 25° and it is for this reason that a time interval of 40-60 minutes should elapse before the hydrosulphite is added, when the colour development-time curve becomes asymtotic.

With the acetic and pyridine in the solution it is evident that their strongly buffering action will prevent the very high hydrogen ion concentration required in this reaction to be obtained by employing the customary concentrations of reagents. As a result alkali is added to the solution prior to the cyanide solution. A similar procedure with good results was followed by Sullivan and Hess (1936).

Very sharp and more reliable colorimetric readings were obtained by using a light filter in the order of 530.

## SUMMARY.

Cystine is determined as cysteine in hydrolysates of plant or biological material of low cystine content. This method is an improvement and also more accurate than the previous one described.

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# Section IX.

# Poultry.

COLES, J. D. W. A. Conjunctivitis of the domestic fowl and an associated Rickettsia-like organism in the conjunctival epithelium ... ... 469

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# Conjunctivitis of the Domestic Fowl and an Associated Rickettsia-like Organism in the Conjunctival Epithelium.

By J. D. W. A. COLES, Section of Poultry, Onderstepoort.

OCULAR ROUP is a well-known complaint of fowls. Every poultryman is familiar with the reddened conjunctiva, the purulent discharge, the cheesy exudate lying deep between the nictitating membrane and eye, the inflammation of the periorbital tissues, the keratitis and even the panophthalmia. In nearly all cases there are some other signs of roup, such as rhinitis, stomatitis, pharyngitis, laryngitis and subcutaneous abscesses over the cranium.

Known causes of " ocular roup " are avitaminosis A, fowl-pox, infectious laryngotracheitis, fowl cholera, streptococcosis and infections produced by *Haemophilus gallinarum* and the cocco-bacilliform bodies of Nelson. The tubercle bacillus will, very rarely, also evoke a conjunctivitis.

From time to time farmers have written to this Institute describing outbreaks of roup that affected only the eyes. We were, however, unable to obtain specimens for examination before November, 1938, when chicks were brought here from Devon in the Transvaal. The two birds, a month old, were undersized on account of the poor ration they received. One had a mild purulent conjunctivitis of both eyes and the lids tended to stick together. The other had a bilateral sero-purulent conjunctivitis, and the tissues round the eyes were moderately swollen; the cornea was only very slightly turbid. The conjunctival epithelial cells of all the affected eyes contained Rickettsia-like organisms in varying numbers. Smears of the conjunctival scrapings were also full of pus cells. From the second chick an unsuccessful attempt was made to infect two adult hens and three cockerels of three months of age. This failure will be referred to later.

In January, 1939, a live White Leghorn pullet, five months old, was received from Frankfort in the Orange Free State. The right eye was normal, except that the iris was lighter in colour than it should have been. These " light eyes " are common in fowls and have nothing to do with conjunctivitis. The left cornea was opaque and the conjunctiva was moderately inflamed. Conjunctival smears from the left eye contained epithelial cells holding Rickettsia-like organisms. Three weeks later infected cells were very difficult to find. When this fowl first arrived, unsuccessful attempts were made to transmit the disease to two other adult fowls, by instilling conjunctival scrapings containing Rickettsias into their conjunctival sacs. Likewise I failed to infect the bird's normal right eye from its left eye. Six calves proved to be refractory. Finally, the faeces of the diseased fowl were instilled into the eyes of normal birds with negative results.

A third outbreak was encountered in Johannesburg in June, 1939. The subject for examination was a nine-months-old White Leghorn pullet. The left eye was normal. The right cornea was slightly opaque and there was a meagre conjunctival discharge. A smear of the conjunctival scrapings was stained with Giemsa, and only a very few epithelial cells were found containing the organisms. Lymphocytes and monocytes, however, were numerous and there was no doubt that the fowl had almost recovered from the infection.

## THE EXPERIMENTAL DISEASE.

It is well known that the great majority of workers on the disease called specific ophthalmia or infectious keratitis of cattle have failed to effect its transmission to experimental animals. On the other hand, direct transmission of ophthalmia from sheep to sheep is relatively easy. Our persistent failures to infect fowls were puzzling. Then I decided to hold small pledgets of cotton wool in forceps and rub them firmly over the infected epithelium. Immediately afterwards, the pledgets were rubbed even more firmly over the conjunctival epithelium of normal birds. Success was immediate. Now we can infect 25 per cent. to 75 per cent. of the experimental fowls. It is interesting to note that one eye may become infected, but not the other. Perhaps a similar technique will permit positive results to be obtained in cattle.

The mode of natural transmission is unknown. All the diseased fowls were kept in two special houses on the poultry plant at Onderstepoort. The condition had never been found in our own flocks. Within six months of commencing our experiments, odd cases of the disease were discovered in different intensive poultry houses. There was never any direct contact between the birds and, as we have shown, artificial transmission is not easy. We can only think that flies spread the infection.

The source of the material for our successful experiments was a cockerel that contracted the disease spontaneously, when put in a cage near that occupied by a naturally infected bird. The incubation period may be as short as two days, and the Rickettsias appear simultaneously with the clinical symptoms. No bird ever developed conjunctivitis without showing the organisms. The usual incubation period is three or four days; sometimes the period is even seven or eight days. Although both eyes are infected simultaneously, one may show symptoms a day or two before the other.

The first symptom is a slight swelling or puffiness of the lower eyelid and this can best be observed from the outside. Photophobia is seen early, if the disease is at all severe. The conjunctiva becomes reddened and swollen, particularly inside the lower lid. There may be a very slight muco-purulent conjunctival exudate, and a smear of this shows it to be composed mainly of pus cells. Only occasionally do the lids tend to stick together.

If the disease is severe, the cornea becomes opaque six to seven days after infection. In another two or three days, blood vessels can be seen growing towards the centre of the cornea from its periphery. If the keratitis takes its usual course and resolves within seven to ten days of its appearance, the blood vessels disappear. In very rare cases, however, the pannus may persist for three or four months; the only fowl that showed this, had the affected cornea opaque and bulging; the opacity was due to scarring. Panophthalmia is a very unusual complication.

The acute inflammation of the conjunctiva generally subsides within a week to a fortnight. It sometimes persists for a month. After this the eye gradually returns to normal, the corneal opacity and any pannus disappearing, and all swelling leaving the lids. But, should the eye have been very bad, there is a not uncommon sequel; as the inflammation improves, the nictitating membrane becomes pulled, up to a third of the way across the eyeball. This defect is of a semi-permanent nature.

Occasionally secondary organisms, such as cocci, invade the diseased conjunctiva, and then the lids stick together more easily and there is a gummy discharge from the eye and a lump of cheesy exudate may form under the nictitating membrane.

Symptoms of a systemic nature may be noted. If a female develops the disease severely in both eyes, she remains mopy and dejected for two to four weeks. But in spite of this, the hens show considerable tenacity and go on feeding. In similar circumstances males do very poorly. Frequently they give up the struggle and refuse to eat, and consequently very soon develop blackish combs and yellowish-green diarrhoea and become emaciated. Most of these males die, even as early as 24 days after infection, or they have to be killed. Severe systemic disturbances were not seen when the disease was confined to one eye.

The inflammatory changes are restricted to the structures of the eye. For this reason, rhinitis, sinusitis and pharyngitis do not develop. Even the periorbital tissues show comparatively little swelling. There is no " roupy " smell.

## ATTEMPTS AT TREATMENT.

Owing to the satisfactory results given by Uleron in the treatment of heartwater, which is due to *Rickettsia ruminantium*, this was the first drug tried..

Three White Leghorn chickens, infected six days previously, got half a Uleron tablet (1 tablet=0·5 gram) *per os* daily for four days. The birds were eight weeks old. Three White Leghorn chickens and another two chickens, all 12 weeks old, that had been infected 13 and 7 days previously, respectively, received half a Uleron tablet each *per os* night and morning. Altogether the birds were dosed 8 times. Five chickens, 13 weeks old, infected 5 days previously, got one Uleron tablet each *per os*, morning and evening. Altogether these birds were dosed 8 times.

Adequate controls were kept. No evidence could be obtained to show that Uleron, in the doses given, could influence the course of the disease. No toxic symptoms were noticed.

Three White Leghorn pullets and another five pullets, infected 9 and 5 days previously, respectively, were each given *per os*, 0·25 gram M. and B. 693; next day the same dose was given in the morning and repeated in the evening and, the day after this again, a single dose was administered in the morning. Thus each pullet got 1 gram of the drug. No toxic symptoms were noted. M. and B. 693 had no adverse effect on the parasites.

One White Leghorn pullet, another 4 pullets and another 7 pullets, infected 17, 13 and 7 days previously, respectively, were dosed *per os*, morning and evening, on two consecutive days with 0·25 gram sulphonamide; on the third morning they were dosed again. Each bird thus received 1·25 grams sulphonamide. No toxic symptoms were observed. The results were again disappointing: apparently the drug has no effect on the Rickettsias.

Uleron, M. and B. 693, and sulphonamide failed to cure the birds in the doses given. Possibly larger doses over a longer period might succeed, but prolonged treatment is not economical on farms.

## IMMUNITY.

Generally speaking, fowls over 18 months old were very resistant to the means of infection employed. Sometimes, however, the disease was produced, and for this reason it is more probable that the method of infection was at fault than that the eyes were not susceptible.

Both eyes of an adult hen resisted infection on two occasions, three months apart. The same applied to a pullet, only the interval was six weeks. But it is dangerous to draw conclusions, for another pullet, infected in both eyes, developed the disease only in the right eye; 22 days after the original infected material was applied to the conjuctiva, symptoms appeared in the left eye. As this left eye had been under observation, it is practically certain that it developed the disease naturally, after experimental infection had failed. Still another pullet was infected unsuccessfully in the left eye, and sixteen days later the disease occurred naturally in the right.

Frequently, when both eyes were infected, the disease, together with the parasites, developed only in one.

Two birds that had the disease badly and recovered, were reinfected after eight and nine months respectively. Even in the eyes that had been so severely affected before, more Rickettsias and clinical symptoms developed. A similar experiment, performed on three other birds, indicated that they were possibly immune, as there was no reappearance of parasites or lesions.

The only conclusions that may be drawn from the above observations are: (1) a recovered eye may be reinfected eight months later, (2) resistance of the eye to experimental infection does not necessarily imply immunity, and (3) infection in one eye does not necessarily lead to the establishment of immunity in the other.

An unsuccessful attempt was made to infect two adult Pekin ducks; the significance of this is questionable.

As far as we know, the natural disease and the attendant parasites are confined to the domestic fowl.

## DESCRIPTION OF THE RICKETTSIA.

The parasites have an intracytoplasmic habitat in the conjunctival epithelial cells. The nuclei of the host cells are never invaded. A cell may be packed with granules. The organisms may be scattered loosely throughout the cytoplasm or be arranged in groups, resembling colonies. These colonies are not attracted to the nuclei, as similar inclusions are in trachoma and blennorrhoea neonatorum of man. If anything, the parasites tend to gravitate to the edges of the cell (v. Fig. 3); the margins thus often show up very clearly when numerous infected cells lie side by side. Sometimes a colony occupies half of the cytoplasm, leaving the other half free.

It is customary to find a number of clean cells together, and then a number of infected cells next to each other. This suggests that a cell is invaded by Rickettsias from the margin of an adjoining cell.

The organisms are very pleomorphic and approximately 0·3$\mu$ to 1·5$\mu$ in size. Some are rods showing bipolar staining; others are plain rods. Then there are coccal forms, triangular forms, comma-shaped forms, whole rings and broken rings. Not infrequently the granules resemble boomerangs. In any one cell, the parasites conform more or less to a type; they may, for instance, be coccal or bacillary in nature.

With Giemsa, most of the organisms stain a light reddish-blue colour. Some of the largest coccal forms may be light blue, resembling initial bodies, and some of the smallest may stain like chromatin, resembling elementary bodies. But there is no sharp division into initial and elementary bodies, such as we find in trachoma and psittacosis.

The granules are Gram-negative and non-acid-fast. With Pinkerton's technique, the organisms stain blue and not red, a fact that excludes this Rickettsia from the group causing typhus and Rocky Mountain spotted fever.

In staining by this method, a smear is made and dried in air, but not fixed. 0·5 Per cent. basic fuchsin in water is applied for three minutes. The fuchsin stain is run off, and the smear decolourized with 0·5 per cent. citric acid in water for a few seconds. The smear is washed in water, and counter-stained with 1 per cent. methylene blue.

It cannot be said definitely that the parasites damage the host cells, but this must be presumed seeing that the conjunctiva becomes inflamed.

The above description of the organisms seems to be sufficient justification for regarding them as a species of Rickettsia. Consequently the name, *Rickettsia conjunctivae galli*, is provisionally proposed for the parasite.

## RELATIONSHIP OF THE ORGANISMS TO THE DISEASE.

In other articles it has been demonstrated how a certain type of conjunctivitis of the sheep, ox, goat, and pig is invariably associated with the presence of Rickettsia-like organisms in the conjunctival epithelial cells. In this paper a similar state of affairs is shown to exist where the domestic fowl is concerned.

With the onset of conjunctivitis in the fowl, conjunctival smears show numerous Rickettsias and pus cells. When healing commences, the parasites disappear and the pus cells are replaced by lymphocytes and some monocytes. Thus, in all essential respects, the disease is on a par with that in the other species of domestic animals.

Corresponding to the course of the acute phase of the disease, the parasites may persist for as long as a month. Occasionally they are present for only a day or two. If the parasites are never present in the eye in sufficient numbers to make their detection rapid, no clinical signs of the disease will be apparent. The converse is not equally true, for smears of clinically normal eyes may contain numerous Rickettsias. But large numbers of parasites are accompanied by abnormal numbers of pus cells and the eye is thus diseased, even if not clinically so. Generally speaking, large numbers of organisms are associated with obvious clinical lesions.

Unless the conjunctival scrapings are contaminated by exudate adhering to the edges of the lids, remarkably few bacteria will be found. Generally they are absent, and the only visible organisms are the Rickettsias. This observation applies also to ophthalmia of the sheep, ox, goat, and pig and tends to show that the presence of the Rickettsias has some etiological significance.

It is not uncommon for a control eye to develop conjunctivitis and contain the parasites, two or three days after the disease has become manifest in the experimentally infected eye. This constitutes more circumstantial evidence that the Rickettsia is the cause. Final proof, however, is still lacking.

## CONCLUSIONS.

An apparently new form of conjunctivitis of the domestic fowl has been described. No doubt the disease has been seen before and called " ocular roup ".

The condition is confined to the structures of the eye. Transmission experiments have led to the successful reproduction of a disease, similar in all respects to that found in nature.

The conjunctivitis is associated invariably with the presence of Rickettsia-like organisms in the conjunctival epithelial cells. Almost identical inclusions have been found in cases of ophthalmia of the sheep, ox, goat, and pig. These fowl parasites have been described and the name, *Rickettsia conjunctivae galli*, proposed for them.

Reasons have been advanced for suggesting that *R. conjunctivae galli* is the true cause of the conjunctivitis.

## ACKNOWLEDGMENTS.

Thanks are due to Dr. R. A. Alexander for staining some smears by Pinkerton's method. Sincere thanks are also due to Mr. T. Meyer for preparing the photomicrographs.

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**An article dealing with the conjunctival inclusions of pigs is now in the press.**

## ILLUSTRATIONS.

The smears of conjunctival epithelial scrapings were all stained with Giemsa.

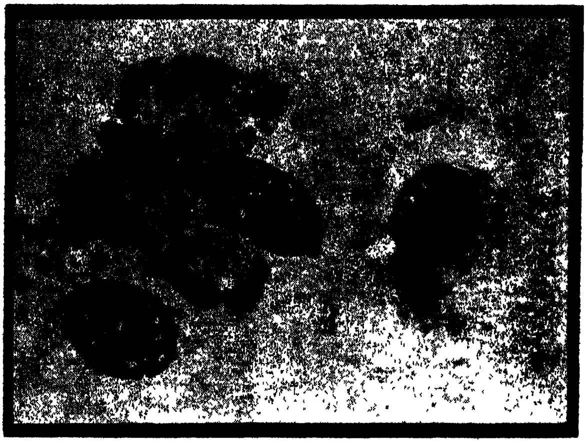

Fig. 1.—1,400×. Conjunctival epithelial cell with the left half of its cytoplasm occupied by a colony of Rickettsia-like organisms. A clean cell is to the right of the infected cell

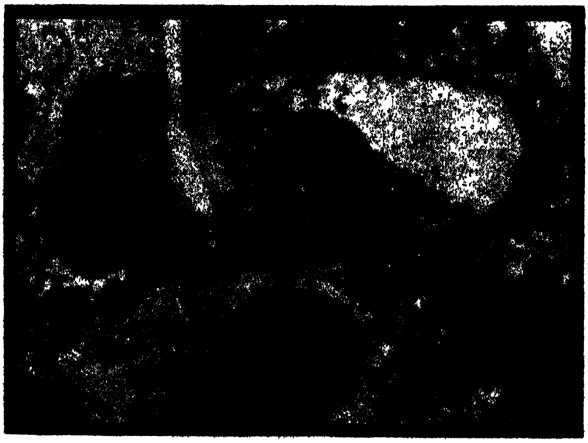

Fig. 2.—1,500×. Conjunctival epithelial cell, half full of parasites.

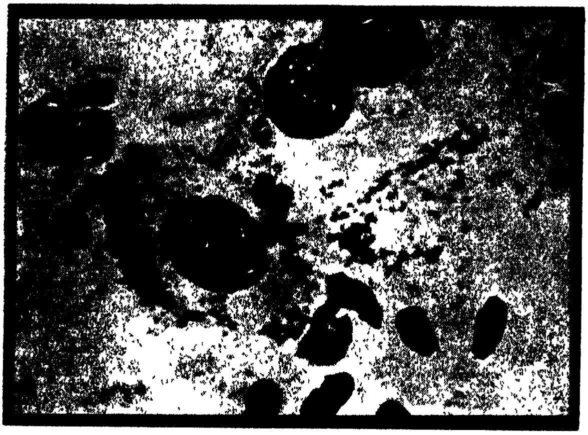

Fig. 3.—1,400×. Conjunctival epithelial cell. The organisms are packed closely along the left edge of the cell; this is a common form of grouping. Other parts of the cytoplasm contain a few parasites. To the right of the cell, and outside it, is a scattered mass of Rickettsias.

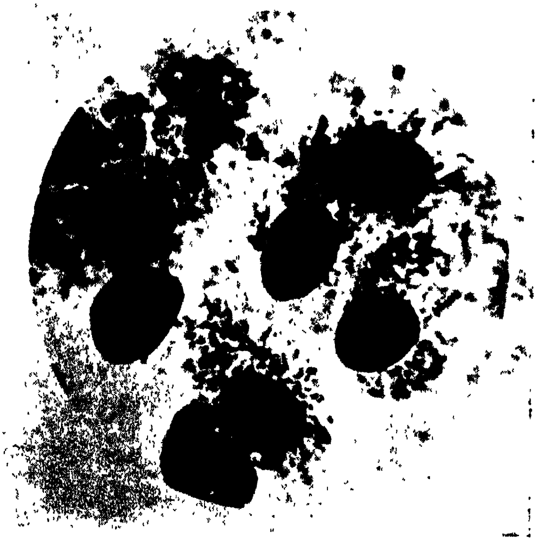

Fig. 4.—1,500×. A group of conjunctival epithelial cells containing organisms

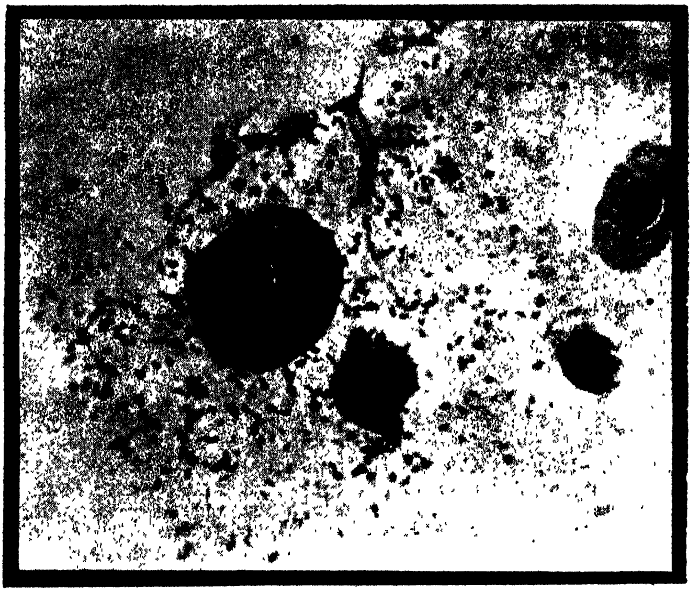

Fig. 5.—1,400×. A conjunctival epithelial cell with numerous Rickettsias dispersed evenly throughout the cytoplasm. To the right of, and below the nucleus, is a lump of extraneous nuclear material.

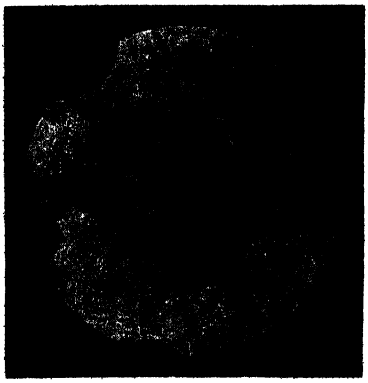

Fig. 6.—1,250×. A conjunctival epithelial cell filled with organisms, most of which are rod-shaped.

# Section X.

# Anatomy.

| | | |
|---|---|---|
| Cloete, J. H. L. and Steyn, H. P. | Anatomical Studies No. 63. An abnormal bovine heart ... ... ... ... ... ... | 481 |
| Jackson, C. and Viljoen, W. C. | Anatomical Studies No. 54. Anomalous course of the left phrenic nerve in a donkey ... ... ... ... ... ... ... ... ... ... ... ... ... | 489 |

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*Volume* 14, *Numbers* 1 *and* 2, *January and April,* 1940.
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Government Printer, Pretoria.

# Anatomical Studies No. 63: An Abnormal Bovine Heart.

By J. H. L. CLOETE and H. P. STEYN, Sections of Anatomy and Surgery, Onderstepoort.

THE majority of the recorded abnormalities of the heart (Schwalbe, 1909) are of relatively simple nature, e.g. patent foramen ovale and localised septal defects. The latter are usually limited to the atrial septum, occurring much less frequently in that of the ventricles. Their frequency is greater in the more basal parts than towards the apex (Bailey and Miller, 1927). Much more rare are anomalies affecting both atria and ventricles, while a search of the literature reveals but a few records of cases in which, in addition to both sets of chambers, the main arterial stems were also involved.

## *Subject.*

The heart is that of a male calf found[1] dead in the veld on the morning of 21-12-36, apparently a few hours subsequent to birth. The calf was by an Afrikander bull (D.O.B. 4819) out of a highgrade Sussex cow (D.O.B. 3425). The foetus had been carried for 296 days, and at birth it compared favourably, as regards both weight (73 lb.) and degree of development, with other calves similarly bred under identical environmental conditions. Other than the cardiac abnormality to be described and several skin abrasions, the autopsy findings were entirely negative. It was decided that the calf had been born alive and that it had breathed.

## *Description of the Heart and Vessels.*

In this description the heart is looked upon as being *in situ* and the animal in the normal standing posture; thus the base of the heart is dorsal, the apex ventral, the right atrium and ventricle cranial and the left chambers caudal.

(*a*) External Appearance.—As will be seen from Fig. 1, the shape of the heart differs from the normal in that it is shortened in the dorso-ventral direction; wider and more rounded at the apex.

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[1] By H. P. S., who was at that time Officer in Charge of the Veterinary Research Station at Armoedsvlakte, near Vryburg, C.P.

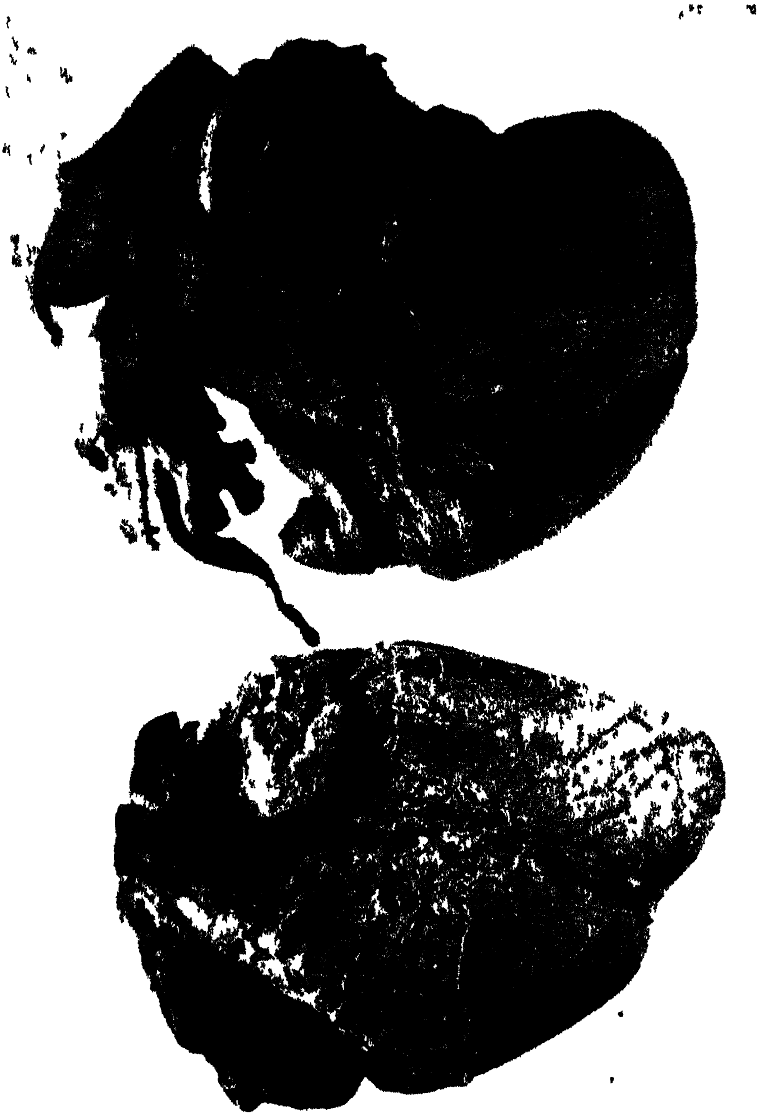

Fig 1 —External appearance left lateral view On the right is the abnormal heart while on the left is shown a normal heart of a new-born calf

Further it is distinctly flattened from side to side. The usual longitudinal grooves are absent, but there is a faint horizontal groove midway down the posterior surface of the ventricular portion. Above this groove a backward protrusion of the ventricular myocard breaks the usual straight line of the caudal border.

The left atrium is attached to the right atrium only, there being no connection between it and the ventricular portion of the heart.

At the base of the heart the usual aortic and pulmonary trunks are replaced by a single large cone-shaped vessel, clearly visible from the left side (Fig. 1). This vessel extends upwards for a distance of two inches before it divides (see Fig. 2) as follows:—

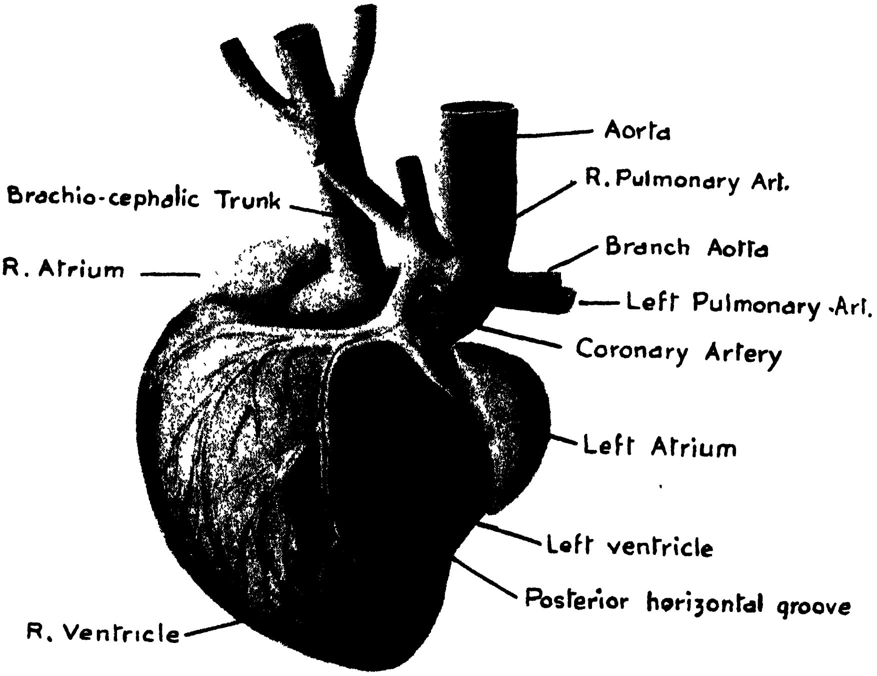

Fig. 2.—External appearance.

(i) *Aorta.*—This, the largest branch, appears to be the direct continuation of the main trunk. It curves upward and backward to reach the dorsal wall of the thoracic cavity.

(ii) *Common Brachiocephalic Trunk.*—This is second in point of size. It arises directly opposite the foregoing vessel and it passes forward towards the entrance to the thoracic cavity.

(iii) *A Fairly Large Vessel* arising at the same level as the above and to the right of it. This probably represents one of the branches of the brachiocephalic trunk. However, in the illustration it is marked as a branch of the aorta.

(iv) *The Right Pulmonary Artery.*—This originates at the left cranial aspect of the main trunk. It is of the same calibre as (iii) but at its base there is a marked constriction.

(v) *The Left Pulmonary Artery.*—Emanating from the base of the aorta, towards the caudal aspect, and having an initial constriction similar to that of the right artery.

At a distance of one inch from the point of origin of the right pulmonary artery there arises a small vessel which, lying upon the left face of the main arterial trunk, runs directly towards the base of the heart where it splits into two branches. These, coursing in opposite directions along the coronary grooves, appear to be the coronary arteries. No further coronary blood supply is detectable.

As is to be expected, neither the ductus arteriosus nor the ligamentum arteriosum is present. The vena cavae and the pulmonary veins open as usual into the right and the left atria respectively.

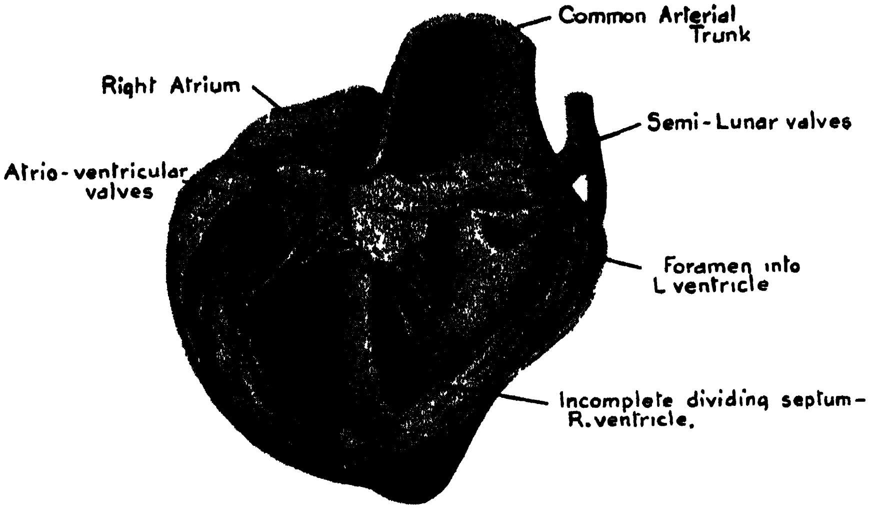

Fig. 3.—Internal appearance, left lateral view.

(*b*) Internal Appearance.—The left atrium has no ventricular communication; however, a patent foramen ovale is encountered. In the right atrium there are no unusual features. As seen in Fig. 3 the right ventricle comprises almost the entire ventricular part of the organ. By a slight longitudinal elevation of its right myocardial wall the chamber is incompletely divided into cranial and caudal compartments. The right atrium opens into the former, while the latter extends ventrally into the apex and dorsally into the main arterial trunk, from which it is demarcated by a three-cuspid semilunar valve. Just ventral to the posterior of these cusps a foramen, about one inch in diameter, opens through the myocardial wall into the vestigial left ventricle. The latter is contained in the posterior protrusion visible externally. It is found to consist of a simple hollow chamber with but one opening—that into the right ventricle. The muscular wall is complete and the cavity is lined by endocardium continuous with that of the larger ventricle.

## *Teratology.*

The mammalian heart develops from a single tube, along the course of which three enlargements appear. In turn these are divided, through the appearance of septa, into paired atria, ventricles and arterial trunks—aortic and pulmonary. In the case under consideration this process has been disturbed, resulting in misplaced division of the ventricles (with consequent atrial anomalies) and total failure of division of the bulbus. The latter remains as a common arterial stem, in the sub-division of which all the main branches of both the aorta and the pulmonary artery are represented.

## *Foetal Circulation.*

In this case a single functional ventricle and a common arterial stem maintained the entire circulation, pulmonary as well as systemic. The former being relatively unimportant in the foetus, constrictions at the bases of the pulmonary arteries served to keep the bulk of the blood-volume in the systemic vessels. For the small volume of blood returning from the lungs to the left atrium there was but one outlet, namely, into the right atrium, thus reversing the usual direction of flow through the foramen ovale.

## *Discussion.*

The significance of this case extends far beyond its teratological rarity—it forms an important contribution to the literature on the foetal circulation.

It is known that into the right atrium are poured two streams of blood of differing quality, namely, the oxygen-poor blood from the cranial vena cava and the relatively pure blood from the caudal vena cava. The traditional belief, based on the teaching of Sabatier (1791), has been that by certain anatomical arrangements within the right atrium, these two streams are kept apart, and that subsequently the purest blood is distributed to the brachio-cephalic circulation. This purely hypothetical conception is based upon the supposed advantages that would accrue from a segregation of pure and impure blood. Save for the apparent highly unsatisfactory work of Reid (1835) there was, until recently, no attempt at experimental verification of the theory. Nevertheless this classical explanation has enjoyed immense popularity and it is to be found, faithfully reproduced, not only in the older texts, but also in works of much more recent origin (e.g. Zeitschmann, 1924; Bailey & Miller, 1927); and this despite the fact that already in 1907 Pohlmann had revived Harvey's (1628) theory of complete admixture of the two streams, and had (1907-9) furnished experimental corroboration which, although perhaps somewhat inconclusive, went far towards discrediting the Sabatier teaching. Extending this investigation, Kellogg (1929) showed that immediately after injection into either the jugular, the anterior or the posterior vena caval veins, of starch solutions or india ink, these substances were recovered in approximately equal concentrations from the two ventricles. But for the possible criticism that by artificial interference the natural mechanism is liable to be disturbed, these results would prove conclusively that in the right atrium there is definite mixing of the bloodstreams. However, Kellogg believes that all the points of criticism may be refuted. In a later study (1930) in which sensitive gaseous analyses of blood samples drawn simultaneously from various regions of the foetal system are the criteria, he records results which vindicate his earlier conclusions.

However, in spite of their acceptance by Arey (1934), who, judging from Kellogg's acknowledgement, appears to have been in a position to appreciate their merit, these findings have not resulted in a settlement of the controversy. Barcroft (1936) points out that in all Kellogg's (1930) results the figures for oxygen content are extremely low. Like Huggett (1927), he finds that in the small ruminant foetus the percentage oxygen saturation varies in decreasing sequence in samples of blood drawn from the posterior vena cava, the carotid and the umbilical artery. Statistical analysis of Barcroft's data shows that the difference between groups two and three (carotid and umbilical artery) is just significant at the five per cent. level of probability, whereas between numbers one and three (posterior vena cava and umbilical artery) there is a difference highly significant even at $P=0 \cdot 01$. Thus, as far as these results are concerned, Barcroft is justified in concluding that " there is on the whole a difference " between samples of blood from the anterior and the posterior systemic arteries. However, in view of the fact that the two significant differences just mentioned are of widely varying order, we consider the qualification, " there is evidence of *some* crossing of the two streams ", to be of equal importance.

Moreover, it must be borne in mind that in the collection of these blood samples the foetuses were probably all held in the same fixed position; this position may have been favourable to an increased flow of blood through the foramen ovale. From anatomical considerations it is not difficult to conceive of such positions; on the other hand it is equally easy to picture positions which might predispose towards thorough mixing of the streams within the right atrium.

The further use, however reservedly, of these highly variable data for the purpose of apportioning the extent of crossing of the streams is questionable. Here exception is taken not so much to the possible inaccuracy of the result as to the implication that there is in existence a mechanism through which only a limited and definitely determinable amount of mixing of the two streams is allowed; again the basis of this idea is the supposedly preferential treatment, in the matter of oxygen supply, of the more cranial part of the foetal body. The limit to which this theory may be stretched is well indicated in Barnard's (1938) discussion of an aneurism of the left ventricle, the result of the left coronary artery taking origin from the pulmonary artery. He maintains that the process had already been instigated in the foetal period by the deprivation of this part of the myocard of " pure blood " from the aorta.

The entire theory is based mainly on the observed relatively large size of the foetal head. Rightly Kellogg (1928) has pointed out that the dominance of this region is limited to the earlier part of prenatal life, and that later the abdominal and pelvic regions undergo rapid growth and differentiation. Statistically it has been shown by one of us[2] that in regions such as the limbs, from early in prenatal life, the true growth-rate of the caudal member is always higher than that of the cranial one. However, in the latter the inception of growth occurs earlier (chronologically) and hence this member obtains a " start " which ensures that for a long time it will be relatively larger than the faster growing caudal member. On this basis the reason for the disproportionate size of the foetal head is its early entry into the growth process; hence the fallacy of hypotheses based upon the supposed accelerated growth, and consequent increased oxygen requirements, of the brachiocephalic region.

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[2] J. H. L. C. in an as yet unpublished study of foetal growth and development in the Merino sheep.

For these reasons we incline towards a modified Harvey-Pohlmann theory which, while admitting the absence of constant, thorough and complete mixing of the two caval streams, regards any difference in the quality of blood in the upper and the lower systemic arteries as " accidental " and physiologically meaningless. Such a modification seems to have been implied by Kellogg, for his contention, after a considerable and varied number of tests, is not that the blood in the two ventricles is always identical (his results prove otherwise), but that such differences as do appear are inconstant, variable and of no moment.

" To those who obtain mental satisfaction from fitting supposedly advantageous mechanisms to physiological ideals, the Harvey-Pohlmann theory may be disappointing. Yet it is by no means certain that there is any necessity in maintaining a difference in the quality of blood distributed to various parts of the body. Circulatory efficiency in the mammalian embryo doubtless depends jointly on the relatively large quantity of swiftly moving blood, and on the large factor of safety in the oxygen supply." In these words Kellogg appears to lay upon those who still persist with the Sabatier conception the onus of definite proof of the necessity for separation. However, in addition to facts already advanced, the case recorded in this article is a natural experiment which has proved effectively that such segregation is not an essential factor in foetal growth and development. Thus the balance has been weighted against the discharge of this onus.

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# Anatomical Studies No. 64.

# Anomalous Course of the Left Phrenic Nerve in a Donkey.

By CECIL JACKSON and W. C. VILJOEN, Section of Anatomy, Onderstepoort.

WHEN during dissection of a one-year-old female donkey (D.O.B. No. 21469) the thorax was opened, it was observed that the left phrenic nerve followed an unusual course and had peculiar relationships, crossing the costal surface of the left lung, and that this anomaly was associated with an irregular arrangement of the pleura on the left side.

The origin of the nerve and its entry into the thorax are as usual, but after it has passed beneath the left subclavian artery its course becomes abnormal. Instead of crossing the costocervical vein and continuing more or less horizontally along the lateral face of the brachiocephalic trunk, it inclines ventrally, crossing the dorsal part of the thymus obliquely and arriving at the pericardium 5 cm. below the origin of the brachiocephalic trunk.

It continues across the pericardium in a position much lower than normal and with a pronounced ventral inclination, so that it reaches the level of the fourth rib only 5 cm. above the sternal extremity of the latter. Failing to return from beneath the pericardiac pleura to the (post-cardial) mediastinum, it continues to occupy a lateral position, being related to the thoracic wall and crossing the costal surface of the lung.

In this part of its course it occupies the dorsal border of a special fold of pleura which is reflected upwards from the diaphragm in the region of the phrenico-costal sinus, is continuous cranially with the pericardiac pleura and is of a lace-like texture. In these respects the arrangement of the pleura is comparable with that normally obtaining on the right side, where the phrenic nerve is enclosed in the caval fold.

The nerve reaches the lung 6 cm. above the junction of the ventral and basal borders (lungs fixed in expiratory phase), crosses the costal surface of the organ, on which it leaves a distinct impression, and at the level of the seventh rib passes through a small fissure (1 cm. in depth) in the basal border of the lung to reach the diaphragm, not at the tendinous centre, but at the costal muscular portion opposite the cranial border and 4 cm. above the sternal extremity of the eighth rib. The post-cardial mediastinum is normal, except for the fact that it does not accommodate the phrenic nerve.

At a distance of 1 cm. respectively in front of and behind the fissure in the border of the lung occur two other similar fissures. Since there is no adhesion between the pulmonary pleura and the special fold in which the nerve is accommodated and in consequence the lung has free mobility relatively to the nerve, it seems likely that at previous times (e.g. during pre-natal life) the nerve may have occupied one or other of these fissures, which presumably developed in order to accommodate it.

The malformation described is apparently unrecorded in the voluminous literature dealing with congenital anomalies of the lungs, pleurae, diaphragm, and nerves.

Mr. Th. Meyer kindly took the photograph which accompanies this note.

*Anomalous Course of the Left Phrenic Nerve.*—The nerve is seen passing obliquely over the thymus and pericardium and then over the lateral surface of the lung. The special fold of pleura in whose dorsal border it is contained is visible behind the cardiac notch of the lung; its lower part has sagged downwards lateral to the costal cartilages (artefact). The fourth and eighth ribs are denoted by numbers.

# AUTHORS' INDEX.

## Volume 14, Nos. 1 and 2.

| | | PAGE |
|---|---|---|
| Cloete, J. H. L. ... | Anatomical studies No. 63. An abnormal bovine heart ... | 481 |
| Coles, J. D. W. A. | Conjunctivitis of the domestic fowl and an associated Rickettsia-like organism in the conjunctival epithelium | 469 |
| De Kock, G. ... ... ... | Swine fever in South Africa ... ... ... ... ... .. ... ... ... .. ... ... | 31 |
| De Waal, H. L. ... ... | The Senecio alkaloids, Part 2. Hydrogenation, hydrolysis and structural results of isatidine ... ... ... ... ... ... ... ... | 433 |
| Du Toit, P. J. ... ... | A study of the mineral content and feeding value of natural pastures in the Union of South Africa ... ... ... ... ... ... ... | 123 |
| | Iodine in the nutrition of sheep (Final Report) ... ... ... ... ... | 329 |
| Groenewald, J. W. | Iodine in the nutrition of sheep (Final Report) ... ... ... ... ... | 329 |
| Jackson, C. ... ... ... | Anatomical studies No. 64. Anomalous course of the left phrenic nerve in a donkey ... ... ... ... ... ... ... ... ... ... ... ... | 489 |
| Keppel, J. J. G. ... | Swine fever in South Africa ... ... ... ... ... ... ... ... ... ... ... ... | 31 |
| Louw, J. G. ... ... ... | A study of the mineral content and feeding value of natural pastures in the Union of South Africa ... ... ... ... ... ... ... | 123 |
| Malan, A. I. ... ... ... | A study of the mineral content and feeding value of natural pastures in the Union of South Africa ... ... ... ... ... ... ... | 123 |
| | Iodine in the nutrition of sheep (Final Report) ... ... ... ... ... | 329 |
| Marais, J. S. C. ... | Futher studies on the amino acid deficiencies of plant proteins ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... | 387 |
| | The dry matter consumption of sheep on natural grazing in the Transvaal ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... | 403 |
| | The utilization by sheep of the proteins contained in the natural grazing during different seasons of the year ... | 415 |
| Mönnig, H. O. ... ... | Treatment against lungworms (*Dictyocaulus filaria*) in sheep ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... | 111 |
| | *Marshallagia marshalli* (Ransom, 1907), Orloff, 1933, and a new species of this genus from sheep in South Africa ... | 115 |
| Myburgh, S. J. ... ... | The carotene content on South African feeds ... ... ... ... ... | 421 |
| Neitz, W. O. ... ... | Eperythrozoonosis in cattle ... ... ... ... ... ... ... ... ... ... ... ... ... | 9 |
| Ortlepp, R. J. ... ... | South African helminths, VII. Miscellaneous helminths, chiefly cestodes ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... | 97 |
| Robinson, E. M. ... | Swine fever in South Africa ... ... ... ... ... ... ... ... ... ... ... ... | 31 |

PAGE

Roets, G. C. S. ... ... Chemical blood studies, VIII. A rapid spectroscopic method for (A) the quantitative determination of haemoglobin in blood and (B) its application for the quantitative estimation of haemoglobin in milk, urine, serum or plasma and faeces ... ... ... ... ... ... ... ... ... ... ... ... ... 451

Rossouw, S. D. ... ... The origin of sulphur in wool, III. An improved cuprous mercaptide method for the determination of cystine in material low in cystine ... ... ... ... ... ... ... ... ... ... 461

Smuts, D. B. ... ... Further studies on the amino acid deficiencies of plant proteins ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 387

The dry matter consumption of sheep on natural grazing in the Transvaal ... ... ... ... ... ... ... ... ... ... ... ... ... ... 403

The utilization by sheep of the proteins contained in the natural grazing during different seasons of the year ... 415

Steyn, H. P. ... ... Anatomical studies No. 63. An abnormal bovine heart ... 481

Van der Merwe, P. K. The significance of fluorine traces in natural waters and a proposed method to effect their removal ... ... ... ... ... 335

A procedure for the micro-determination of fluorine ... . . 359

Viljoen, W. C. ... ... Anatomical studies No. 64. Anomalous course of the left phrenic nerve in a donkey ... ... ... ... ... ... ... ... ... ... 489

# SUBJECT INDEX.

## Volume 14, Nos. 1 and 2.

**Amino Acid.**

Further studies on the amino acid deficiencies of plant proteins ... ... ... ... ... 387

**Anatomy.**

Anatomical studies No. 63. An abnormal bovine heart ... ... ... ... ... ... ... ... .. 481
Anatomical studies No. 64. Anomalous course of the left phrenic nerve in a donkey ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 489

**Bovine.**

Anatomical studies No. 63. An abnormal bovine heart ... ... ... ... ... ... ... ... .. 481

**Carotene.**

The carotene content of some South African feeds ... ... ... ... ... ... ... ... ... ... 421

**Cattle.**

Eperythrozoonosis in cattle ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 9

**Cestodes.**

South African helminths, VII. Miscellaneous helminths, chiefly cestodes ... ... 97

**Chemical Blood Studies.**

Chemical blood studies, VIII. A rapid spectroscopic method for (A) the quantitative determination of haemoglobin in blood and (B) its application for the quantitative estimation of haemoglobin in milk, urine, serum or plasma and faeces ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 451

PAGE

**Conjunctivitis.**

Conjunctivitis of the domestic fowl and an associated Rickettsia-like organism in the conjunctival epithelium ... ... ... ... ... ... ... ... ... ... ... ... ...... ... 469

**Cystine.**

The origin of sulphur in wool, III. An improved cuprous mercaptide method for the determination of cystine in material low in cystine ... ... ... ... 461

**Dictyocaulus filaria.**

Treatment against lungworms (*Dictyocaulus filaria*) in sheep ... ... ... ... ... ... 111

**Donkey.**

Anatomical studies No. 64. Anomalous course of the left phrenic nerve in a donkey ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... . ... ... ... ... ... 489

**Dry Matter Consumption.**

The dry matter consumption of sheep on natural grazing in the Transvaal ... 403

**Eperythrozoonosis.**

Eperythrozoonosis in cattle ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 9

**Faeces.**

Chemical blood studies, VIII. A rapid spectroscopic method for (A) the quantitative determination of haemoglobin in blood and (B) its application for the quantitative estimation of haemoglobin in milk, urine, serum or plasma and faeces ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 451

**Feeding Value.**

A study of the mineral content and feeding value of natural pastures in the Union of South Africa ... ... ... . . ... ... ... ... ... ... ... ... ... ... ... ... 123

**Fluorine.**

The significance of fluorine traces in natural waters and a proposed method to effect their removal ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 335

A procedure for the micro determination of fluorine ... ... ... ... ... ... ... ... 359

**Fowl.**

Conjunctivitis of the domestic fowl and an associated Rickettsia-like organism in the conjunctival epithelium ... ... ... ... ... ... ... ... ... ... ... ... ...... ... 469

**Haemoglobin.**

Chemical blood studies, VIII. A rapid spectroscopic method for (A) the quantitative determination of haemoglobin in blood and (B) its application for the quantitative estimation of haemoglobin in milk, urine, serum or plasma and faeces ... ... ... ... ... ... ... .. ... ... ... ... ... ... ... ... ... ... 451

**Heart.**

Anatomical studies No. 63. An abnormal bovine heart ... ... ... ... ... ... ... ... 481

**Helminths.**

South African helminths, VII. Miscellaneous helminths, chiefly cestodes ... ... 97

**Iodine.**

Iodine in the nutrition of sheep (Final Report) ... ... ... ... ... ... ... ... ... ... 329

**Isatidine.**

The senecio alkaloids, Part 2. Hydrogenation, hydrolysis and structural results of isatidine ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 433

**Lungworms.** PAGE

Treatment against lungworms (*Dictyocaulus filaria*) in sheep ... ... ... ... ... ... ... 111

**Marshallagia Marshalli.**

*Marshallagia marshalli* (Ransom, 1907), Orloff, 1933, and a new species of this genus from sheep in South Africa ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 115

**Milk.**

Chemical blood studies, VIII. A rapid spectroscopic method for (A) the quantitative determination of haemoglobin in blood and (B) its application for the quantitative estimation of haemoglobin in milk, urine, serum or plasma and faeces ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 451

**Mineral Content.**

A study of the mineral content and feeding value of natural pastures in the Union of South Africa ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 123

**Natural Grazing.**

The utilization by sheep of the proteins contained in the natural grazing during different seasons of the year ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 415

**Natural Water.**

The significance of fluorine traces in natural waters and a proposed method to effect their removal ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 335

**Pastures.**

A study of the mineral content and feeding value of natural pastures in the Union of South Africa ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 123

**Phrenic Nerve.**

Anatomical studies No. 64. Anomalous course of the left phrenic nerve in a donkey ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 489

**Plasma.**

Chemical blood studies, VIII. A rapid spectroscopic method for (A) the quantitative determination of haemoglobin in blood and (B) its application for the quantitative estimation of haemoglobin in milk, urine, serum or plasma and faeces ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 451

**Proteins.**

Further studies on the amino acid deficiencies of plant proteins ... ... ... ... ... 387

The utilization by sheep of the proteins contained in the natural grazing during different seasons of the year ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 415

**Rickettsia.**

Conjunctivitis of the domestic fowl and an associated Rickettsia-like organism in the conjunctival epithelium ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 469

**Senecio.**

The senecio alkaloids, Part 2. Hydrogenation, hydrolysis and structural results of isatidine ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 433

**Serum.**

Chemical blood studies, VIII. A rapid spectroscopic method for (A) the quantitative determination of haemoglobin in blood and (B) its application for the quantitative estimation of haemoglobin in milk, urine, serum or plasma and faeces ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 451

**Sheep.** PAGE

Treatment against lungworms (*Dictyocaulus filaria*) in sheep ... 111
*Marshallagia marshalli* (Ransom, 1907), Orloff, 1933, and a new species of this genus from sheep in South Africa ... 115
Iodine in the nutrition of sheep (Final Report) ... 320
The dry matter consumption of sheep on natural grazing in the Transvaal ... 403
The utilization by sheep of the proteins contained in the natural grazing during different seasons of the year ... 415

**Spectroscopic Method.**

Chemical blood studies, VIII. A rapid spectroscopic method for (A) the quantitative determination of haemoglobin in blood and (B) its application for the quantitative estimation of haemoglobin in milk, urine, serum or plasma and faeces ... 451

**Sulphur.**

The origin of sulphur in wool, III. An improved cuprous mercaptide method for the determination of cystine in material low in cystine ... 461

**Swine Fever.**

Swine fever in South Africa ... 31

**Urine.**

Chemical blood studies, VIII. A rapid spectroscopic method for (A) the quantitative determination of haemoglobin in blood and (B) its application for the quantitative estimation of haemoglobin in milk, urine, serum or plasma and faeces ... 451

**Wool.**

The origin of sulphur in wool, III. An improved cuprous mercaptide method for the determination of cystine in material low in cystine ... 461

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